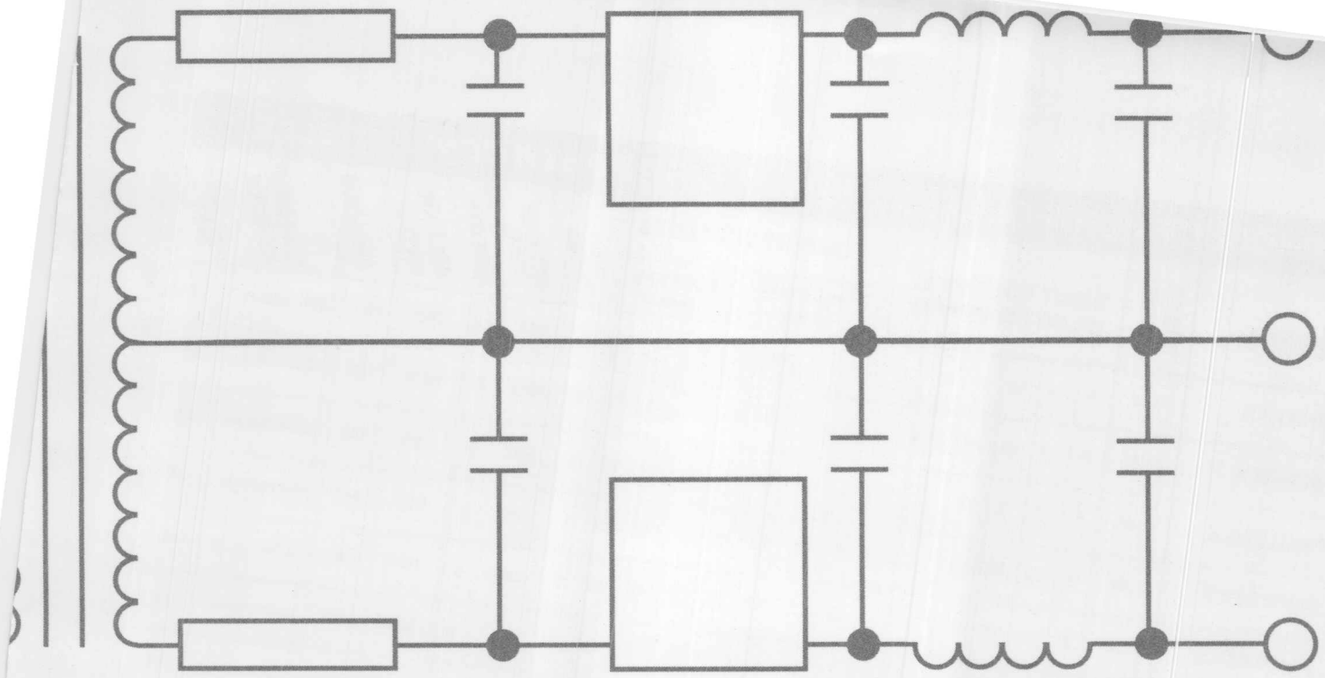


BURR-BROWN
POWER CONVERTIBLES™

DC/DC CONVERTER HANDBOOK

BURR-BROWN®

PRODUCT PORTFOLIO

POWER CONVERTIBLES™

SERIES	POWER (WATTS)	INPUT VOLTAGES (PLUS OR MINUS)						OUTPUT VOLTAGES							# OF CHANNELS	OUTPUTS PER CHANNEL	REGULATION	ISOLATION VOLTAGE	SHEILDING	SHORT CIRCUIT PROTECTION	PAGE #
								PLUS OR MINUS				PLUS AND MINUS									
HPR1XX	0.75	5	12	15	24			5		12	15	5	12	15	1	S/D	U	750	NO	Momentary	17
HPR4XX	0.75	5	12	15	24			5		12	15	5	12	15	1	S/D	U	1000	NO	Momentary	20
PWR59XX	1.00	5	12	15	24			5	9	12	15	5	12	15	1	S/D	R	750	NO	Continuous	23
PWR11XX	1.50	5	12	15	24			5	9	12	15	5	12	15	1	S/D	U	500	NO	Momentary	25
PWR13XX	1.50	5	12	15				5		12	15	5	12	15	1	S/D	U	4000	NO	5 Seconds	29
PWR1726	1.50			15										15	1	D	U	5000	NO	Continuous	33
PWR60XX	1.80	5	12	15	24			5					12	15	1	S/D	R	500	NO	Continuous	35
PWR3XX	2.00	5	12	15	24	28	48	5		12	15	5	12	15	2	S/D	U	1000	YES	Continuous	39
LPR3XX	2.25	5	12						9						1	S	U	500	NO	Momentary	41
PWR1017	3.00			15										15	4	D	U	1000	YES	Momentary	43
PWR12XX	3.00	5	12	15	24			5	9	12	15	5	12	15	1	S/D	U	500	NO	Momentary	48
HPR2XX	3.00	5	12	15	24							5	12	15	4	D	U	750	NO	Momentary	52
PWR40XX	4.00	5	12	15	24			5		12			12	15	1	S/D	U	1000	NO	Momentary	55
PWR5XX	4.00	5	12	15	24	28	48	5		12	15	5	12	15	4	S/D	U	750	YES	Momentary	59
HPR7XX	5.00	5	12	15				5				5	12	15	1	S/D	U	500	YES	Momentary	61
PWR1546A	5.00	5												15	1	D	R	750	YES	Continuous	64
PWR70XX	5.00	5	12	15	24		48	5				5	12	15	1	S/D	R	500	YES	Continuous	67
PWR8XX	5.00	5	12	15	24	28	48	5					12	15	2	T	U	1000	YES	Momentary	70
PWR62XX	5.20	5	12	15	24	28	48	-5.2							1	S	R	500	YES	Continuous	72
PWR16XX	6.00	5	12	15	24			5		12			12	15	1	S/D	U	500	YES	Momentary	74
PWR51XX	9.00	5											12	15	1	D	R	750	YES	15 Seconds	77
PWR53XX	15.00	9-18		18-36		36-72		5		12	15	5	12	15	1	S/D/T	R	500	YES	Continuous	79

BURR-BROWN®

POWER CONVERTIBLES™

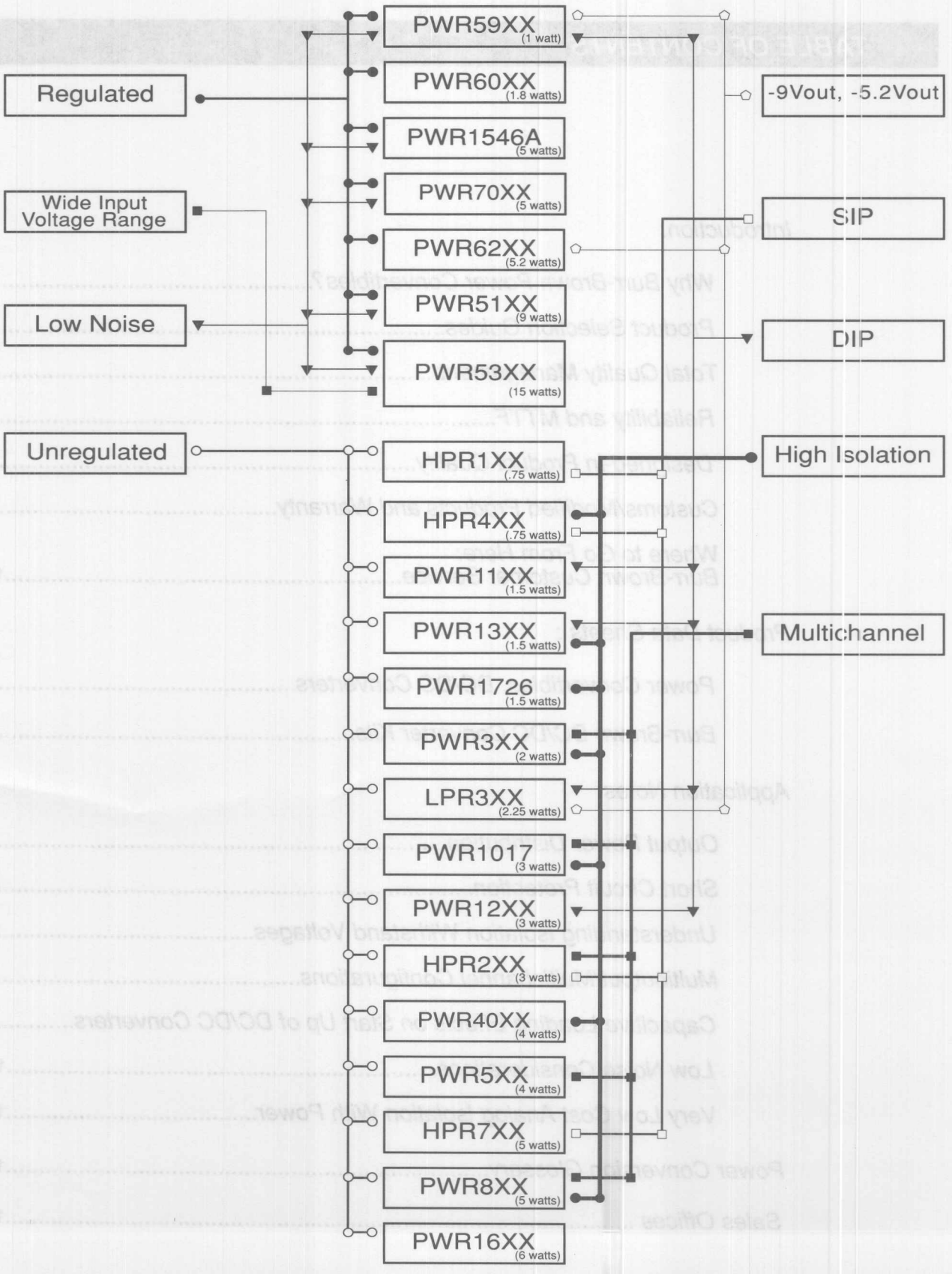
DC/DC CONVERTER HANDBOOK

Member of the 

Printed in U.S.A.

TABLE OF CONTENTS

PRODUCT CATEGORY OVERVIEW



WHY POWER CONVERTIBLES ?

Power Convertibles is the Burr-Brown product line offering one of the world's most comprehensive selections of low-power DC/DC converters. Each Power Convertible is a total solution that does not require additional components to work. In considering size, price, and performance you will find premier products at affordable prices with Power Convertibles.

Burr-Brown is a leading designer and manufacturer of precision microcircuits and microelectronic-based systems for use in data acquisition, signal conditioning, and control applications throughout the world. To better serve the specialized requirements of the DC/DC market, Power Convertibles engineering and manufacturing are in a dedicated organization and facility. The focus that the Power Convertibles group gives the DC/DC converter market has produced leading-edge products and highly competitive pricing. Specialized product features include solutions for high-isolation applications, space-sensitive designs and the industry's only multiple-channel outputs.

Burr-Brown is prepared to give you the best customer service in the industry — whether you need additional technical literature, technical assistance from factory trained applications engineers, or to place an order. For immediate assistance, contact your local Burr-Brown salesperson or representative (see listing at the end of this handbook). Or, in the USA, call our Customer Service Center at 1-800-548-6132.

Technical Literature

In addition to product data sheets, as found in this book, Burr-Brown has an extensive library of other useful publications. A brief summary: *DC/DC Converter Selection Guide*, *DC/DC Converter Cross Reference Guide*, *IC Data Book Vol. 33* and *IC Data Book Supplement Vol. 33B*, reliability reports, and application notes. We also offer a comprehensive product selection guide on a PC diskette.

About This Book

This book has been organized to facilitate the choices a design engineer encounters in choosing a power product. The Product Portfolio will give you, at a glance, an overview of the DC/DC converters available. Then, individual Selection Guides call out specific product features and capabilities. Detailed Product Data Sheets supply the complete specifications for each product series. They are followed by Application Notes for more effective use of the products, a Glossary of power conversion terminology and a complete directory of Burr-Brown sales offices and representatives.

SELECTION GUIDES

UNREGULATED POWER CONVERTIBLES

Model	Rated Power (Watts)	Features	Page
HPR1XX	0.75	Miniature SIP	17
HPR4XX	0.75	High Isolation, Miniature SIP	20
PWR11XX	1.50	Low Cost, DIP	25
PWR13XX	1.50	High Isolation, DIP	29
PWR1726	1.50	Very High Isolation	33
PWR3XX	2.00	Multichannel	39
LPR3XX	2.25	LAN Applications (9 volt output)	41
PWR1017	3.00	Multichannel	43
PWR12XX	3.00	Low Cost, DIP	48
HPR2XX	3.00	Multichannel, SIP	52
PWR40XX	4.00	Low Cost	55
PWR5XX	4.00	Multichannel	59
HPR7XX	5.00	Low Cost, SIP	61
PWR8XX	5.00	Triple Output	70
PWR16XX	6.00	Low Cost	74

REGULATED POWER CONVERTIBLES

Model	Rated Power (Watts)	Regulation		Features	Page
		Line (%)	Load (%)		
PWR59XX	1.00	±0.3	0.4	DIP, Low Cost	23
PWR60XX	1.80	±0.2	0.5	Low Noise, Low Cost	35
PWR1546A	5.00	±0.02	0.02	Ultra Low Noise	64
PWR70XX	5.00	±0.02	0.04	Standard Pinout, Low Cost	67
PWR62XX	5.20	±0.04	0.06	ECL Power (5.2V output)	72
PWR51XX	9.00	±0.02	0.04	High Power Density	77
PWR53XX	15.00	±0.2	1.0	Wide Input Voltage Range, Triple Output	79

SELECTION GUIDES

MULTICHANNEL POWER CONVERTIBLES

Model	Total Rated Power (Watts)	Number of Channels	Outputs per Channel	Total Number of Outputs	Page
PWR3XX	2.00	2	Single or Dual	2, 3, or 4	39
PWR1017	3.00	4	Dual	8	43
HPR2XX	3.00	4	Dual	8	52
PWR5XX	4.00	4	Single or Dual	4, 5, 6, 7, or 8	59
PWR8XX	5.00	2	Single + Dual	3	70

HIGH ISOLATION POWER CONVERTIBLES

Model	Rated Power (Watts)	Test Voltage (AC, Vpeak 60Hz,60s)	Rated Voltage (VDC)	Page
HPR4XX	0.75	3000	1000	20
PWR13XX	1.50	8000	4000	29
PWR1726	1.50	8000	5000	33
PWR3XX	2.00	3000	1000	39
PWR60XX-HV	2.00	3000	1000	35
PWR1017	3.00	3000	1000	43
PWR40XX	4.00	3000	1000	55
PWR8XX	5.00	3000	1000	70

LOW NOISE POWER CONVERTIBLES

Model	Rated Power (Watts)	Noise Out (mVp-p) Typ	Max	Features	Page
PWR59XX	1.00	50		Low Cost, DIP	23
PWR1546A	5.00	0.6	1.0	Ultra Low Noise	64
PWR70XX	5.00	30		Standard Pinout, Low Cost	67
PWR51XX	9.00	6	35	High Power Density	77
PWR53XX	15.00	40	75	Wide Input Voltage Range Triple Output	79

SELECTION GUIDES

SIP POWER CONVERTIBLES

Model	Total Rated Power (Watts)	Package Size (inches)	Features	Page
HPR1XX	0.75	0.78 x 0.25 x 0.41	Miniature Package, Low Cost	17
HPR4XX	0.75	0.78 x 0.25 x 0.41	High Isolation, Miniature SIP	20
HPR2XX	3.00	2.22 x 0.35 x 0.41	Quad Channel, Low Cost	52
HPR7XX	5.00	2.22 x 0.35 x 0.41	High Power Density, Low Cost	61

DIP POWER CONVERTIBLES

Model	Total Rated Power (Watts)	Regulation	Features	Page
PWR59XX	1.00	Yes	Low Noise, Low Cost	23
PWR11XX	1.50	No	Industry Alternate Source	25
PWR13XX	1.50	No	High Isolation	29
PWR12XX	3.00	No	Industry Alternate Source	48

WIDE INPUT RANGE POWER CONVERTIBLES

Model	Total Rated Power (Watts)	Input Range (VDC)	Features	Page
PWR53XX	15.00	9-18 18-36 36-72	Single, Dual & Triple Outputs	79

SPECIAL OUTPUT VOLTAGE POWER CONVERTIBLES

Model	Total Rated Power (Watts)	Special Output Voltage	Features	Page
PWR59XX	1.00	-9 Volts	Regulated, DIP, LAN	23
LPR3XX	2.25	-9 Volts	Low Cost, DIP,LAN	41
PWR62XX	5.20	-5.2 Volts	ECL Power Supply	72

TOTAL QUALITY MANAGEMENT

The Burr-Brown Power Convertibles product line delivers the best performing power conversion products at the lowest prices in the industry. We continue to grow due to a total addiction to quality. We expect to drive to new heights in power with that same dedication to performance and price. You can attribute this dedication to one thing, our employees. We recognize that "you can't buy quality...it must come from within". That is why we consider our corporate strength and vision to lie within it's most valued resource — people.

T.E.A.M. Q™

Technical Excellence And Manufacturing Quality (T.E.A.M. Q) is a cross-functional team approach that incorporates the requirements of the customer and ensures world class products with high reliability. It is an operational framework within which all organizations operate and all Power Convertibles are designed, manufactured and marketed.

The success of this program is realized by combining structured technical systems with participative management focused social systems. This leading-edge integration creates a balanced systems approach, which maximizes effectiveness and responsiveness to change.

The goal of T.E.A.M. Q is Six Sigma Compliance to all specified requirements (virtually 100% conformance). The following systems perpetuate continuous improvement from theory through benchmarking to execution.

Technical systems focus on :

1) Employee driven Statistical Process Control
2) Conservative engineering design rules
3) Stringent manufacturing in-process controls
4) Continually improving designs and processes
5) Reliability testing and MTTF calculations

Social systems focus on:

1) Total employee involvement and empowerment
2) Employee training

RELIABILITY AND MTTF

Calculated MTTF (also called Predicted MTTF)

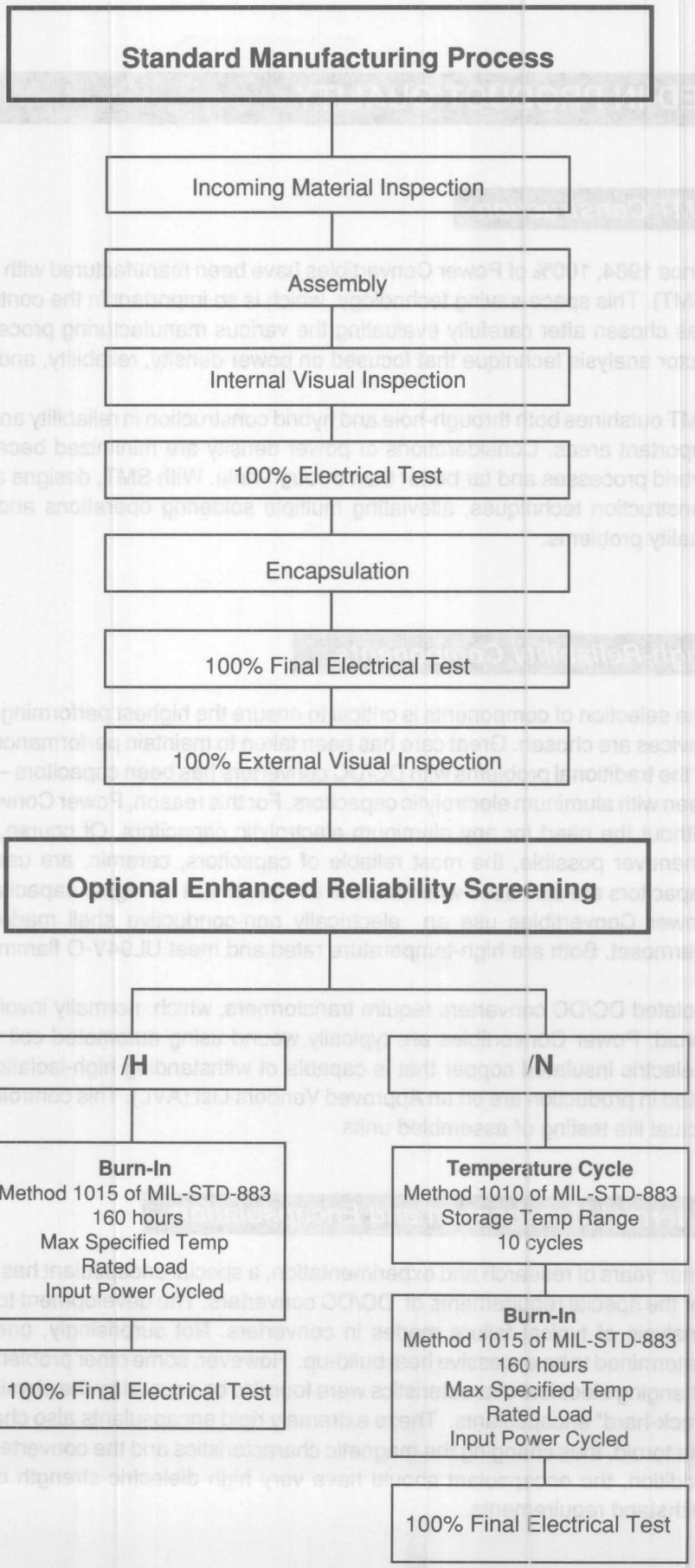
Power Convertibles leads the industry in reliability with some of the highest MTTF's (Mean Time To Failure) for DC/DC converters. Our Quality Assurance department performs all predicted MTTF calculations per MIL-HDBK-217, Circuit Stress Analysis method. MTTF is derived from a formula that the U.S. military has developed. Some manufacturers only include "critical" components or use the less realistic parts-count method. The version or "method" of the formula Burr-Brown uses for Power Convertibles takes into account every component and its stress levels compared to its rating. For example, each capacitor is given a failure factor based on its rated voltage and the actual application voltage. The failure factors are then statistically added to achieve a total overall predicted lifetime. In this equation there are several very broad parameters included such as temperature and environment. The more harsh the environment, the more likely a failure. The U.S. military has supplied these factors with titles such as: ground benign, naval sheltered, etc. **Calculated** MTTF provides the user with a relative measure of reliability. However, demonstrated MTTF provides the user with substantially more comprehensive information about the long term reliability of the product.

Demonstrated MTTF

Because of concerns about the usefulness of calculated MTTF, Power Convertibles developed a policy for measuring demonstrated MTTF. We wanted to make actual experiments (such as burn-in, power cycling, etc.) that would prove that designs and manufacturing processes are reliable. We balance the number of units and the time on test to provide a large number of device-hours under test (i.e., multiply the # of devices by the time under test). Basically a number of units are tested at full load, maximum rated temperature, and then data is collected. The results are incorporated into a "Reliability Report". Because the test is done at maximum temperature and many customers need MTTF numbers at other temperatures, a standard equation is used to extrapolate the MTTF down to room temperature (an Arrhenius relationship). This is explained as well as the other conditions of the testing and mathematics in the published report. It is our policy that a Reliability Report is published on every new Power Convertible series.

Enhanced Reliability Product Screening

Customers may choose two additional levels of screening to meet the specific requirements of their high-reliability applications. This screening is available on **ALL** models. The advanced reliability program is a part of Power Convertibles' comprehensive Total Quality Management philosophy. These same screening processes are used in whole or in part where applicable in the development, characterization, and qualification of our designs and manufacturing processes. This program is designed to reduce infant mortality, customer rework, field failures, and equipment downtime. The additional screening processes are summarized in the following flowcharts:


Standard Manufacturing Process
Incoming Material Inspection
Assembly
Internal Visual Inspection
100% Electrical Test
Encapsulation
100% Final Electrical Test
100% External Visual Inspection
Optional Enhanced Reliability Screening
/H
/N
Burn-In
Method 1015 of MIL-STD-883
160 hours
Max Specified Temp
Rated Load
Input Power Cycled
100% Final Electrical Test
Temperature Cycle
Method 1010 of MIL-STD-883
Storage Temp Range
10 cycles
Burn-In
Method 1015 of MIL-STD-883
160 hours
Max Specified Temp
Rated Load
Input Power Cycled
100% Final Electrical Test

DESIGNED-IN PRODUCT QUALITY

SMT Construction

Since 1984, 100% of Power Convertibles have been manufactured with Surface Mount Technology (SMT). This space-saving technology, which is so important in the continual age of miniaturization, was chosen after carefully evaluating the various manufacturing processes and using a weighted factor analysis technique that focused on power density, reliability, and total cost.

SMT outshines both through-hole and hybrid construction in reliability and total cost — two extremely important areas. Considerations of power density are minimized because SMT is comparable to hybrid processes and far better than through-hole. With SMT, designs are simplified in terms of the construction techniques, alleviating multiple soldering operations and subsequent reliability and quality problems.

High-Reliability Components

The selection of components is critical to ensure the highest performing, smallest, and most reliable devices are chosen. Great care has been taken to maintain performance, reliability and quality. One of the traditional problems with DC/DC converters has been capacitors — and the most failures have been with aluminum electrolytic capacitors. For this reason, Power Convertibles have been designed without the need for any aluminum electrolytic capacitors. Of course, capacitors are needed, so whenever possible, the most reliable of capacitors, ceramic, are used in all designs. Tantalum capacitors are also used when there is a requirement for higher capacitance within a small area. All Power Convertibles use an electrically non-conductive shell made of either thermoplastic or thermoset. Both are high-temperature rated and meet UL94V-O flammability specifications.

Isolated DC/DC converters require transformers, which normally involve winding of wire around a toroid. Power Convertibles are typically wound using automated coil winders. The wire is a high dielectric insulated copper that is capable of withstanding high-isolation voltage. All components used in production are on an Approved Vendors List (AVL). This controlled list of parts is qualified by actual life testing of assembled units.

Thermal Management and Encapsulation

After years of research and experimentation, a special encapsulant has been developed that is ideal for the special requirements of DC/DC converters. The development took into account the in-depth analysis of typical failure modes in converters. Not surprisingly, one of the major factors was determined to be excessive heat build-up. However, some other problems such as latent failures and changing electrical characteristics were found to be caused by the physical stress from the traditional "rock-hard" encapsulants. These extremely rigid encapsulants also changed the shape and form of the toroid, thus changing the magnetic characteristics and the converter's electrical performance. In addition, the encapsulant should have very high dielectric strength due to the isolation voltage withstand requirements.

The answer to these encapsulation concerns was to create **Iso-ThermoFlex™** a low-cost encapsulant with: 1) excellent thermal transfer capabilities to remove the excessive heat generated by power components; 2) high isolation dielectric strength to reduce the possibility of any high voltage breakdown in the converter, and 3) flexibility to ensure that Power Convertibles do not have problems like those induced in other DC/DC converters by the physical stress of very rigid encapsulants. In addition, the flexibility of the material allows for better failure analysis so that any problems can be investigated and resolved more quickly.

Iso-ThermoFlex has a thermal conductivity of approximately 0.00122 cal/square cm/degrees C/sec/cm, which compared to silicon rubber and rigid epoxy is 63% and 34% better respectively. The flammability rating meets UL94V-O, has a dielectric withstand voltage of 500VDC/mil, and is resistant to extended 85°C and 85% Relative Humidity. Iso-ThermoFlex encapsulant is resistant to chemicals commonly used in the electronics industry.

Every effort has been made to make the system engineer's job easier and thermal management is no exception. Design guidelines ensure that **heatsinks are not required** for any Power Convertible. This eliminates potential temperature problems when having to deal with heatsinks or other hot-running DC/DC converters. Here again, Iso-ThermoFlex encapsulant provides excellent thermal conductivity and helps alleviate any problem of this nature.

Manufacturing Control

100% of Power Convertibles are production tested. In fact, every unit actually undergoes two tests — one before encapsulation and one after encapsulation. This dual testing, along with other manufacturing controls and processes ensures a top-quality product.

All DC/DC converters are manufactured using stringent in-process controls and quality inspections. Each product is marked with the specific model ordered, a date code and a job code. Each lot is fully traceable to incoming materials.

Electrostatic Discharge

ESD Class 3 sensitivity levels are met for all product and shipments are made in anti-static packaging. Manufacturing temperatures and humidity controls are in place to ensure proper ESD control and each manufacturing workstation is grounded and has static dissipative mats. Electrostatic discharge can cause damage ranging from performance degradation to complete device failure. Burr-Brown Corporation recommends that all Power Convertibles be handled and stored using appropriate ESD protection methods.

CUSTOM / MODIFIED PRODUCTS

The Power Convertibles strategy is to be the leader in low-cost DC/DC converters. Our focus is therefore on standard products, not custom. Nevertheless, special OEM power conversion requirements will be considered. If you're faced with the need for unique mechanical or electrical characteristics, our outstanding engineering staff may be able to help solve the problem.

Although, "customs" are not our focus, special circumstances might warrant modifying a standard product. First, determine exactly what electrical or mechanical characteristics your application requires. Next, find the product in this catalog that most closely reflects your requirements. This might be a different input or output voltage, a certain pin-out, or special testing of a specific parameter for guaranteed qualification. Then call your nearest Burr-Brown sales office for further investigation.

RETURNS AND WARRANTY SERVICE

When returning products for any reason, it is necessary to contact Burr-Brown prior to shipping for authorization and shipping instructions. In the U.S.A., contact our Tucson headquarters. In other countries, contact your local Burr-Brown sales office or representative. Please ship returned units prepaid and supply the original purchase order number and date, along with an explanation of the malfunction. Upon receipt of the returned unit Burr-Brown will verify the malfunction and will inform you of the warranty status, cost to repair or replace, credits, and status of replacement units where applicable.

WHERE TO GO FROM HERE: BURR-BROWN SALES AND SERVICE

GETTING TECHNICAL ASSISTANCE

We have a technical field sales force, backed up by an experienced staff of technical applications specialists. They are eager to assist you in selecting the right product for your application. This free service is available from our Tucson-based headquarters (1-800-548-6132) and all sales offices.

GETTING PRODUCT DATA SHEETS AND OTHER TECHNICAL LITERATURE

Product Data Sheets and manuals similar to those you see here, but perhaps containing more recent revisions, are available for most of the products in this book. To obtain any of these items, contact your local Burr-Brown salesperson or representative listed at the end of this handbook.

HOW TO PLACE AN ORDER

You can place orders via telephone, FAX, mail, TWX, or TELEX with any authorized Burr-Brown field sales office, sales representative, or our headquarters in Tucson. A complete list of sales offices is at the back of this book. When placing an order, please provide complete information, including model number with all option designations, product description or name, quantity desired, and ship-to and bill-to addresses. This will help us serve you most efficiently.

ORDERING INFORMATION

Example:

PWR13 07 A /N

Reliability Screening Option - pick from 2 options as described in Reliability and MTTF section.

Package Option - Pick from A,B,C: applies only to those devices that have more than one pin arrangement. See Product Data Sheets for package diagrams. In Example: Package A refers to the DIP package option.

Model Number - Reference XX on Product Data Sheets In Example: Model #07 of this series has 12VIN and 12 VOUT with125mA of Output Current.

Product Series - In Example: PWR13 has 1.5 Watts of Unregulated Output Power.

PRICE AND TERMS

Contact your local Burr-Brown sales office for pricing. Prices and specifications are subject to change without notice. For U.S.A. customers, all prices are FOB Tucson, Arizona, U.S.A., in U.S. dollars. Applicable federal, state and local taxes are extra. Terms are net 30 days.

QUOTATIONS

Price quotations made by Burr-Brown or its authorized sales representatives are valid for 30 days. Delivery quotations are subject to reconfirmation at the time of order placement.

PRODUCT DATA SHEETS

Power Convertibles DC/DC Converters

DC/DC Converter Kits

BURR-BROWN®

HPR1XX SERIES

0.75 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

MINIATURE SINGLE-IN-LINE PACKAGE

FEATURES

- LOW COST
- SINGLE-IN-LINE PACKAGE (SIP)
- INTERNAL INPUT AND OUTPUT FILTERING
- NON-CONDUCTIVE CASE
- HIGH OUTPUT POWER DENSITY: 10 WATTS/INCH^3
- EXTENDED TEMPERATURE RANGE: -25°C TO +85°C
- HIGH EFFICIENCY: TO 80%

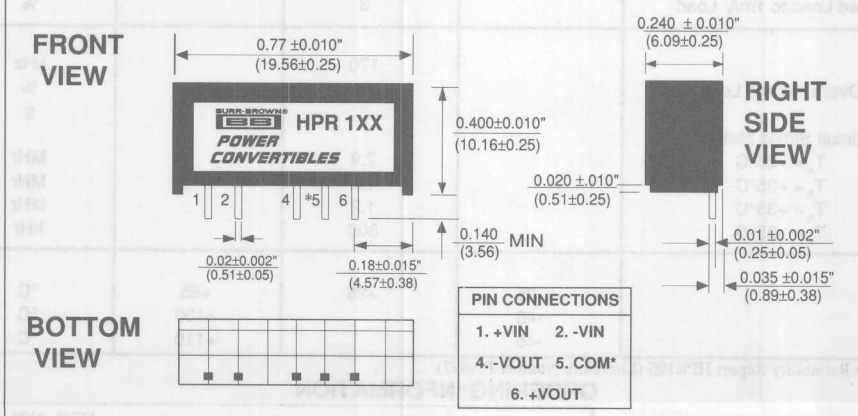
DESCRIPTION

The HPR1XX Series uses advanced circuit design and packaging technology to realize superior reliability and performance. A 170kHz push-pull oscillator is used in the input stage. Beat-frequency oscillator problems are reduced when using the HPR1XX Series with high frequency isolation amplifiers such as the Burr-Brown ISO122.

Reduced parts count and high efficiency add to the reliability of the HPR1XX Series. The high efficiency of the HPR1XX Series means less internal power dissipation, as low as 190mW. With less heat to have to dissipate the HPR1XX Series can operate at higher temperatures with no degradation of reliable operation. In addition, the high efficiency of the HPR1XX Series means the series is able to offer greater than 10 W/inch^3 of output power density. Operation down to no load will not impact the reliability of the series, although this product has a 1mA minimum load for specifications purposes.

The HPR1XX Series provides the user low cost without sacrificing reliability. The use of surface mounted devices and manufacturing technologies make it possible to offer premium performance and low cost.

MECHANICAL



* Common pin not present on single output models.

Notes:

All dimensions are in inches (millimeters).

GRID: 0.100 inches (2.54 millimeters)

PIN PLACEMENT TOLERANCE: ± 0.015"

Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is phosphor bronze with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT MIN LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)
HPR100	5	5	150	20	216	10	69
HPR102	5	15	50	20	199	5	75
HPR103	5	±5	±75	20	208	5	70
HPR104	5	±12	±30	20	192	5	78
HPR105	5	±15	±25	20	190	5	79
HPR106	12	5	150	10	90	5	69
HPR107	12	12	62	10	81	5	77
HPR109	12	±5	±75	10	87	5	72
HPR110	12	±12	±30	10	78	5	80
HPR111	12	±15	±25	10	78	5	80
HPR112	15	5	150	8	72	5	69
HPR116	15	±12	±30	8	63	5	80
HPR117	15	±15	±25	8	63	5	80
HPR118	24	5	150	8	44	15	70
HPR120	24	15	50	8	41	15	76
HPR121	24	±5	±75	8	41	15	76
HPR122	24	±12	±30	8	40	15	78
HPR123	24	±15	±25	8	40	15	79

Note: Other input to output voltages may be available. Please contact factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.5	5	5.5	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
		21.6	24	26.4	VDC
Voltage Rise Time	See Typical Performance Curves & Application Notes: "Capacitive Loading Effects on Start-Up of DC/DC Converters"				
ISOLATION					
Rated Voltage		750			VDC
Test Voltage	60 Hz, 10 Seconds	750			Vpk
Resistance			10		GΩ
Capacitance			25	100	pF
Leakage Current	V_{ISO}= 240VAC, 60Hz		2	8.5	µArms
OUTPUT					
Rated Power			750		mW
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Ripple & Noise	BW = DC to 10MHz		45		mVp-p
	BW =10Hz to 2MHz		30		mVrms
HPR103	BW = DC to 10MHz		90		mVp-p
Voltage	1mA Load, V_{OUT} = 5V			7	VDC
	1mA Load, V_{OUT} = 12V			15	VDC
	1mA Load, V_{OUT} = 15V			18	VDC
Temperature Coefficent			.01		%/Deg C
REGULATION					
Line Regulation	High Line to Low Line		1		%/%Vin
Load Regulation (5V out only)	Rated Load to 1mA Load		10		%
Load Regulation (All other Models)	Rated Load to 1mA Load		3		%
GENERAL					
Switching Frequency			170		kHz
Frequency Change	Over Line and Load		24		%
Package Weight			2		g
MTTF per MIL-HDBK-217, Rev. E *	Circuit Stress Method				
Ground Benign	T_A = +25°C		7.9		MHr
Fixed Ground	T_A = +35°C		1.9		MHr
Naval Sheltered	T_A = +35°C		1.2		MHr
Airborne Uninhabited Fighter	T_A = +35°C		300		kHr
TEMPERATURE					
Specification		-25	+25	+85	°C
Operation		-40		+100	°C
Storage		-40		+110	°C

*For demonstrated MTTF results reference Burr-Brown Reliability Report HPR105 (Literature Number PA697)

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....450mW
Short Circuit Protection.....1 second
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

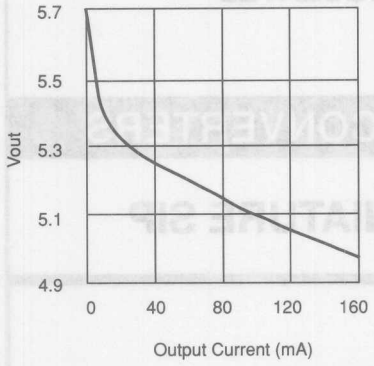
HPR 1XX /H

Device Family
PWR Indicates DC/DC converter
Model Number
Selected from Table of Electrical Characteristics
Screening Option

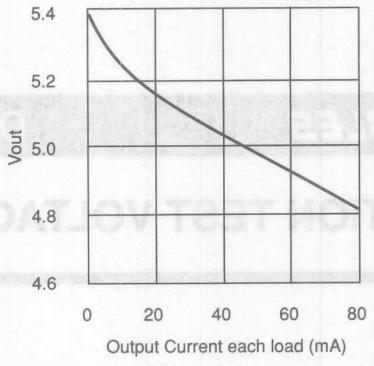
TYPICAL PERFORMANCE CURVES

T_A= +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

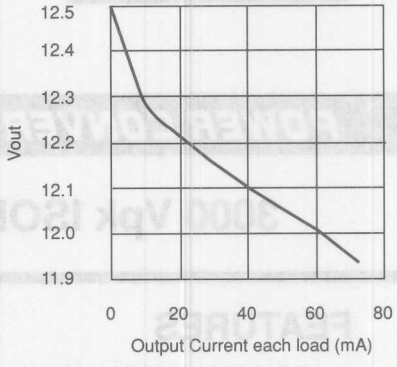
VOUT VS LOAD
(5 Vout Models)



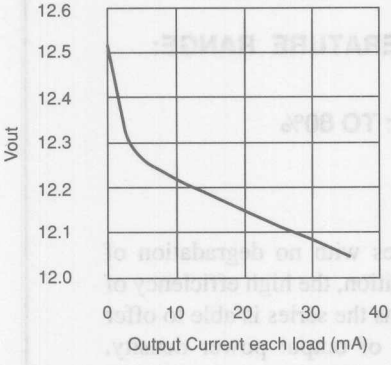
VOUT VS LOAD
(±5 Vout Models)



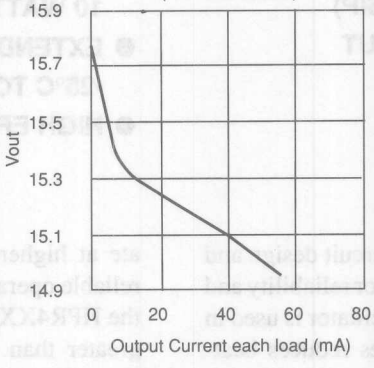
VOUT VS LOAD
(12 Vout Models)



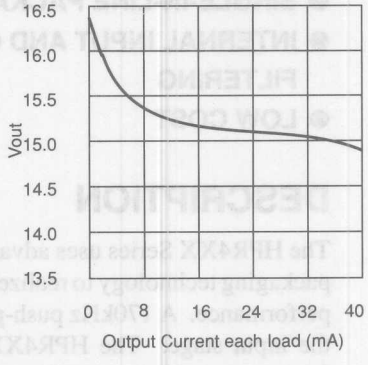
VOUT VS LOAD
(±12 Vout Models)



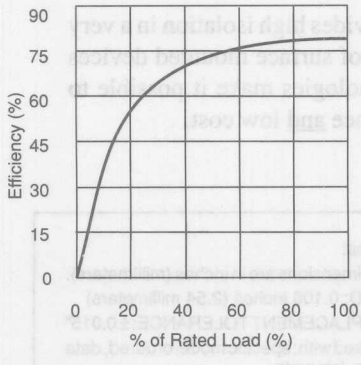
VOUT VS LOAD
(15 Vout Models)



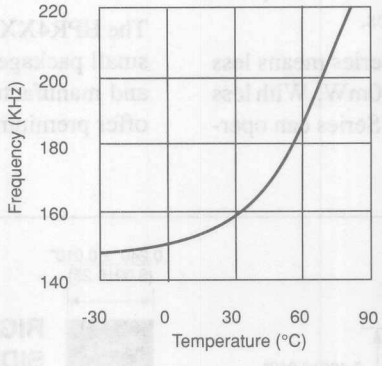
VOUT VS LOAD
(±15 Vout Models)



EFFICIENCY VS LOAD



OSCILLATION FREQUENCY VS TEMPERATURE



BURR-BROWN®

HPR4XX SERIES

0.75 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

3000 Vpk ISOLATION TEST VOLTAGE MINIATURE SIP

FEATURES

- HIGH ISOLATION VOLTAGE: 3000 VPK TEST
- SINGLE-IN-LINE PACKAGE (SIP)
- INTERNAL INPUT AND OUTPUT FILTERING
- LOW COST
- NON-CONDUCTIVE CASE
- HIGH OUTPUT POWER DENSITY: 10 WATTS/INCH^3
- EXTENDED TEMPERATURE RANGE: -25°C TO +85°C
- HIGH EFFICIENCY: TO 80%

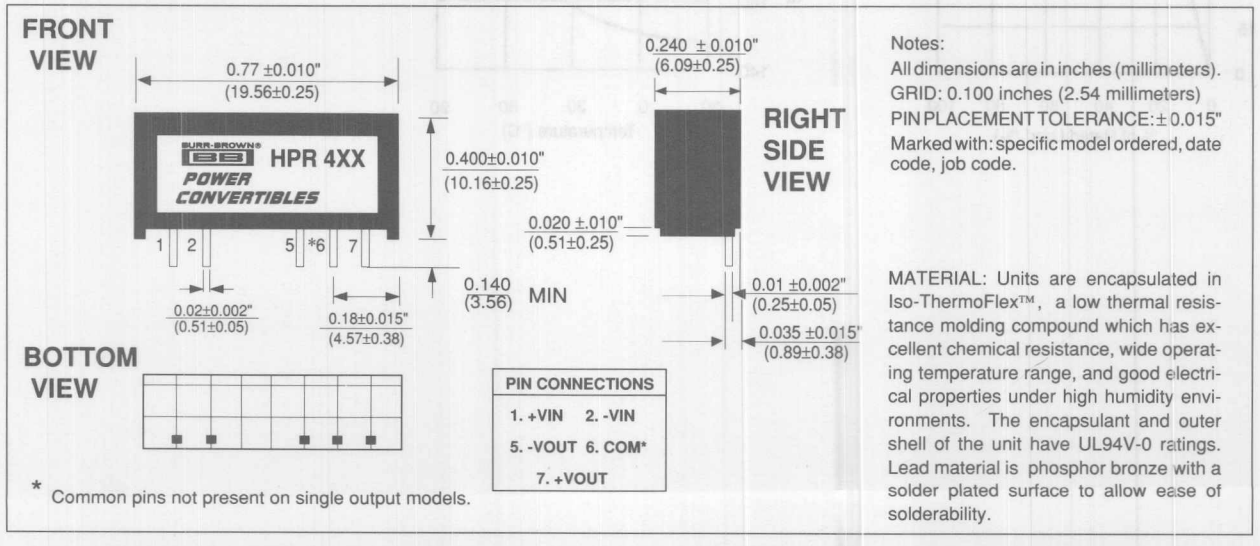
DESCRIPTION

The HPR4XX Series uses advanced circuit design and packaging technology to realize superior reliability and performance. A 170kHz push-pull oscillator is used in the input stage. The HPR4XX Series reduces beat-frequency oscillator problems when used with high frequency isolation amplifiers such as the Burr-Brown ISO122. Reduced parts count and high efficiency add to the reliability of the HPR4XX Series.

The high efficiency of the HPR4XX Series means less internal power dissipation, as low as 190mW. With less heat to have to dissipate the HPR4XX Series can operate at higher temperatures with no degradation of reliable operation. In addition, the high efficiency of the HPR4XX Series means the series is able to offer greater than 10 W/inch^3 of output power density. Operation down to no load will not impact the reliability of the series, although this product has a 1mA minimum load for specifications purposes.

The HPR4XX Series provides high isolation in a very small package. The use of surface mounted devices and manufacturing technologies make it possible to offer premium performance and low cost.

MECHANICAL



* Common pins not present on single output models.

Notes:
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is phosphor bronze with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT MIN LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)
HPR400	5	5	150	20	216	5	69
HPR402	5	15	50	20	199	5	75
HPR403	5	±5	±75	20	208	5	70
HPR404	5	±12	±30	20	192	5	78
HPR405	5	±15	±25	20	190	5	79
HPR406	12	5	150	10	90	5	69
HPR407	12	12	62	10	81	5	77
HPR409	12	±5	±75	10	87	5	72
HPR410	12	±12	±30	10	78	5	80
HPR411	12	±15	±25	10	78	5	80
HPR412	15	5	150	8	72	5	69
HPR416	15	±12	±30	8	63	5	80
HPR417	15	±15	±25	8	63	5	80
HPR418	24	5	150	8	44	15	70
HPR420	24	15	50	8	42	15	75
HPR421	24	±5	±75	8	41	15	76
HPR422	24	±12	±30	8	40	15	78
HPR423	24	±15	±25	8	40	15	79

Note: Other input to output voltages may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at Ta = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.5	5	5.5	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
		21.6	24	26.4	VDC
Voltage Rise Time	See Typical Performance Curves & Application Notes: "Capacitive Loading Effects on Start-Up of DC/DC Converters"				
ISOLATION					
Rated Voltage		1000			VDC
Test Voltage	60Hz, 60 Sec	3000			Vpk
Resistance			10		GΩ
Capacitance			15		pF
Leakage Current	V_{ISO}= 240VAC, 60Hz		2	7	µArms
OUTPUT					
Rated Power			750		mW
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Ripple & Noise	BW = DC to 10MHz		45		mVp-p
	BW =10Hz to 2MHz		30		mVrms
HPR403	BW = DC to 10MHz		90		mVp-p
Voltage	1 mA Load, V_{OUT} = 5V			7	VDC
	1 mA Load, V_{OUT} = 12V			15	VDC
	1 mA Load, V_{OUT} = 15V			18	VDC
Temperature Coefficent			.01		%/Deg C
REGULATION					
Line Regulation	High Line to Low Line		1		%/%Vin
Load Regulation (5V out only)	Rated Load to 1mA Load		10		%
Load Regulation (All other Models)	Rated Load to 1mA Load		3		%
GENERAL					
Switching Frequency			170		kHz
Frequency Change	Over Line and Load		24		%
Package Weight			2		g
MTTF per MIL-HDBK-217, Rev. E	Circuit Stress Method				
Ground Benign	T_A = +25°C		7.9		MHr
TEMPERATURE					
Specification		-25	+25	+85	°C
Operation		-40		+100	°C
Storage		-40		+110	°C

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....450mW
Short Circuit Protection.....1 second
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

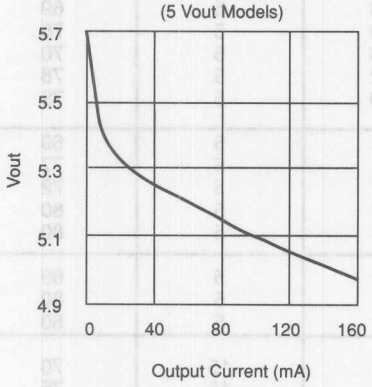
HPR 4 XX /H

Device Family
PWR Indicates DC/DC converter
Model Number
Selected from Table of Electrical Characteristics
Screening Option

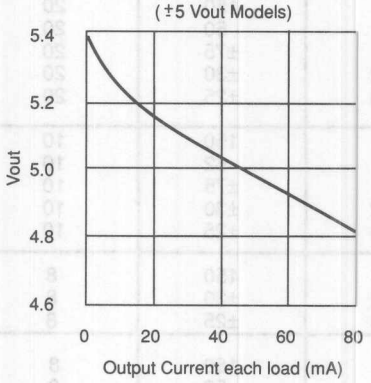
TYPICAL PERFORMANCE CURVES

T_A= +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

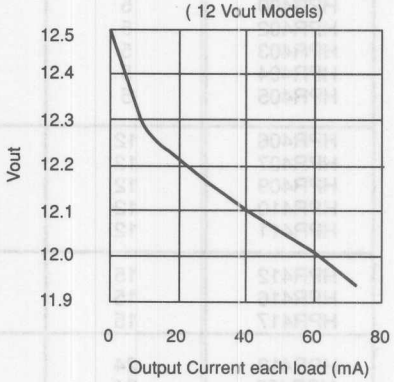
VOUT VS LOAD
(5 Vout Models)



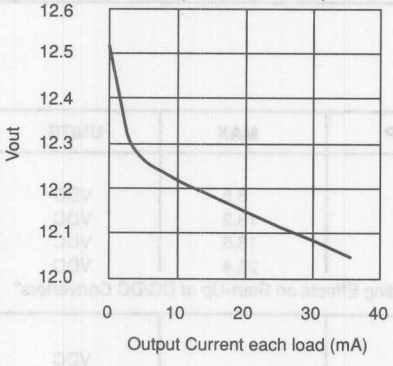
VOUT VS LOAD
(±5 Vout Models)



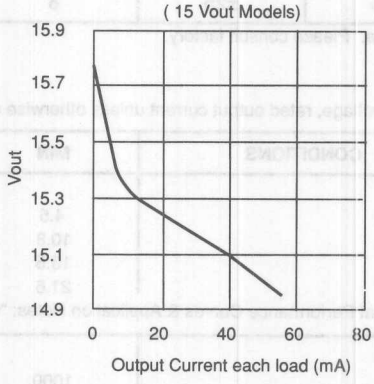
VOUT VS LOAD
(12 Vout Models)



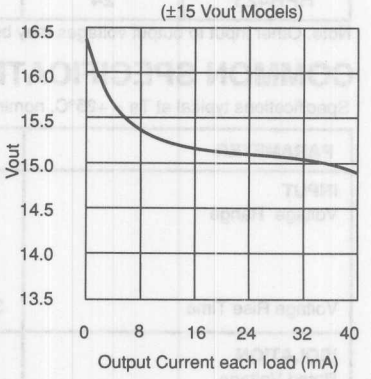
VOUT VS LOAD
(±12 Vout Models)



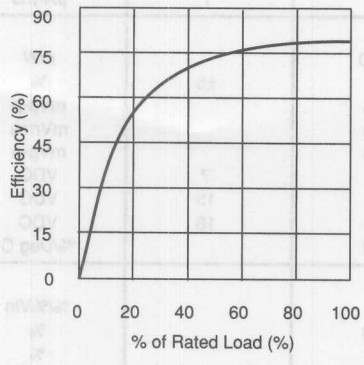
VOUT VS LOAD
(15 Vout Models)



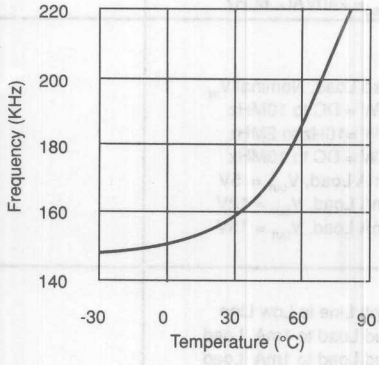
VOUT VS LOAD
(±15 Vout Models)



EFFICIENCY VS LOAD



OSCILLATION FREQUENCY VS TEMPERATURE



BURR-BROWN®

PWR59XX SERIES

.5 to 1 WATT
REGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

24-PIN DUAL-IN-LINE PACKAGE

FEATURES

- HIGH RELIABILITY
- 24-PIN DIP PACKAGE
- INTERNAL INPUT AND OUTPUT FILTERING
- SHORT-CIRCUIT CURRENT LIMITED
- THERMAL OVERLOAD PROTECTION
- BUILT-IN STANDOFFS
- INDUSTRY STANDARD PINOUT

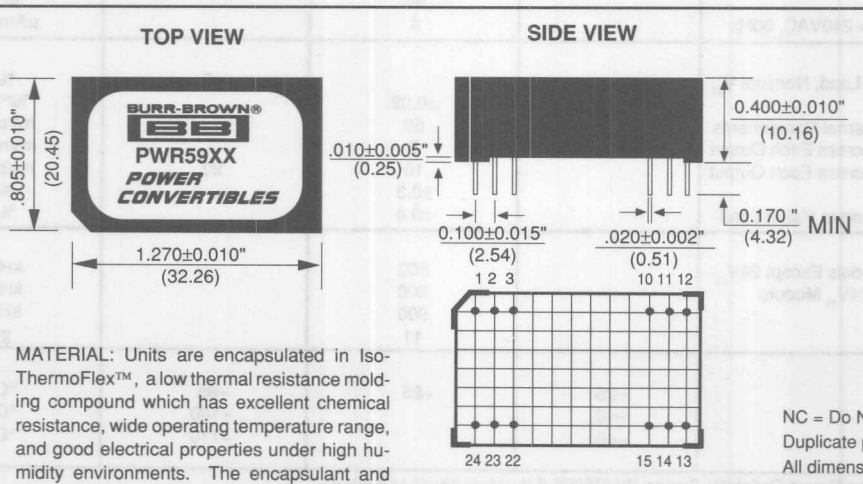
DESCRIPTION

The PWR59XX Series offers an extensive selection of input and output voltage combinations to choose from, including a 9V output for Cheapernet local area networking. Both single and dual output voltages are available. These miniature, regulated DC/DC converters come in a 24-pin dual-in-line package for applications where space is at a premium. This small size is possible through the use of surface mounted devices and manufacturing technologies. SMT processes and components also make it possible to offer the PWR59XX Series with no power derating over an extended temperature range of –25°C to +85°C.

A push-pull input stage ensures fixed frequency, non-saturating operation of the oscillator section of the PWR59XX Series. MOSPOWER transistors are used as high speed switching elements. These rugged devices provide higher frequency to 500kHz operation, and uncomplicated drive circuitry. Reduced component count means higher reliability. High frequency operation means smaller magnetics. Higher isolation voltages are possible, due to the section wound transformer. Higher frequency operation also means less noise generation within the system's bandwidth.

Linear regulators are used in the output stage to minimize variations in output voltage due to line and load changes. These devices also provide short-circuit current limiting and thermal overload protection.

MECHANICAL



MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

PIN CONNECTIONS

PIN #	SINGLES	DUALS
1	+VIN	+VIN
2	NC	–VOUT
3	NC	Common
10	–VOUT	Common
11	+VOUT	+VOUT
12	–VIN	–VIN
13	–VIN	–VIN
14	+VOUT	+VOUT
15	–VOUT	Common
22	NC	Common
23	NC	–VOUT
24	+VIN	+VIN

NC = Do Not Connect
Duplicate pin functions are internally connected.
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise specified.

Model	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT NO LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)	RATED OUTPUT POWER (mW)
PWR5900	5	5	100	40	175	10	57	500
PWR5901	5	9	111	40	345	10	57	1000
PWR5902	5	12	83	40	345	10	57	1000
PWR5903	5	15	67	40	345	10	57	1000
PWR5904	5	±5	±50	40	175	10	57	500
PWR5905	5	±12	±42	40	345	10	57	1000
PWR5906	5	±15	±33	40	345	10	57	1000
PWR5907	12	5	100	35	100	30	42	500
PWR5908	12	9	111	35	170	30	49	1000
PWR5909	12	12	83	35	150	30	55	1000
PWR5910	12	15	67	35	150	30	55	1000
PWR5911	12	±5	±50	35	76	30	55	500
PWR5912	12	±12	±42	35	150	30	55	1000
PWR5913	12	±15	±33	35	150	30	55	1000
PWR5914	15	5	100	30	76	20	44	500
PWR5915	15	9	111	30	135	20	50	1000
PWR5916	15	12	83	30	120	20	55	1000
PWR5917	15	15	67	30	120	20	55	1000
PWR5918	15	±5	±50	30	60	20	55	500
PWR5919	15	±12	±42	30	120	20	55	1000
PWR5920	15	±15	±33	30	120	20	55	1000
PWR5921	24	5	100	15	43	10	48	500
PWR5922	24	9	111	15	83	10	50	1000
PWR5923	24	12	83	15	73	10	55	1000
PWR5924	24	15	67	15	73	10	55	1000
PWR5925	24	±5	±50	15	40	10	55	500
PWR5926	24	±12	±42	15	73	10	60	1000

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Input Voltage Range		4.75	5	5.25	VDC
		11.4	12	12.6	VDC
		14.25	15	15.75	VDC
		22.8	24	25.2	VDC
ISOLATION					
Rated Voltage		750			VDC
Test Voltage	60 Hz, 10 Seconds	750			Vpk
Resistance			10		GΩ
Capacitance			50		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		4		µArms
OUTPUT					
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Temperature Coefficient			±0.02		%/°C
Ripple & Noise	No External Components		50		mVp-p
(BW = DC to 20MHz)	10µF Across Each Output		5		mVrms
	10µF Across Each Output		10	20	mVp-p
Line Regulation			±0.3		%
Load Regulation	No Load to Rated Load		±0.4		%
GENERAL					
Switching Frequency	All Models Except 24V_{IN}		500		kHz
	24V_{IN} Models		200		kHz
MTTF per MIL-HDBK-217, Rev. E*			900		kHr
Package Weight			11		g
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–40		+100	°C
Storage		–40		+110	°C

* For demonstrated MTTF results reference Burr-Brown Reliability Report PWR5905 (Literature Number PA648).

ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration ..... Continuous
Internal Power Dissipation 1.5W
Lead Soldering Temperature (10seconds, max) ..... +300°C

ORDERING INFORMATION

PWR 59XX /H

Device Family
PWR Indicates DC/DC Converter
Model Number
Selected from Table of Electrical Characteristics
Screening Option

BURR-BROWN®

PWR11XX SERIES

1.5 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

DUAL-IN-LINE PACKAGE

FEATURES

- LOW COST
- INDUSTRY-STANDARD PACKAGE
- SINGLE AND DUAL OUTPUTS
- INTERNAL INPUT AND OUTPUT FILTERING
- 24-PIN DIP PACKAGE
- BUILT-IN STANDOFFS

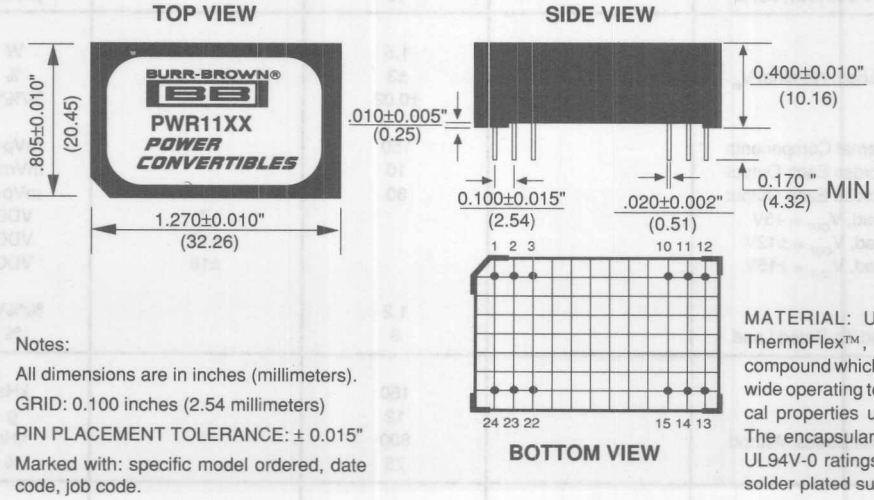
DESCRIPTION

The PWR11XX Series offers a broad line of low-cost, high-performance, unregulated, single and dual output DC/DC converters in a 24-pin DIP package. These miniature converters offer better performance and lower cost in industry-standard packages and pin-outs. The PWR11XX Series is internally filtered. No external parts are necessary.

Surface mounted components and Iso-ThermoFlex™ encapsulant allow for superior reliability, excellent thermal dissipation, and an extended temperature range of –25°C to +85°C at no extra cost.

The PWR11XX Series is ideal for use on high-density PC boards where isolated, unregulated, power is needed. Standoffs allow for PC board cleaning, helping preserve isolation. They also allow for visual inspection of solder joints.

MECHANICAL



Notes:
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise noted.

MODEL	NOMINAL INPUT VOLTAGE	RATED OUTPUT VOLTAGE	RATED OUTPUT CURRENT	INPUT CURRENT		REFLECTED RIPPLE CURRENT
				NO LOAD	RATED LOAD	
Units	VDC	VDC	mA	mA	mA	mAp-p
PWR1100	5	5	300	30	400	45
PWR1101	5	12	125	30	400	45
PWR1102	5	15	100	30	400	45
PWR1103	5	±5	±150	30	400	45
PWR1104	5	±12	±63	30	400	45
PWR1105	5	±15	±50	30	400	45
PWR1106	12	5	300	30	175	25
PWR1107	12	12	125	30	175	25
PWR1108	12	15	100	30	175	25
PWR1109	12	±5	±150	30	175	25
PWR1110	12	±12	±63	30	175	25
PWR1111	12	±15	±50	30	175	25
PWR1112	15	5	300	30	140	20
PWR1113	15	12	125	30	140	20
PWR1114	15	15	100	30	140	20
PWR1115	15	±5	±150	30	140	20
PWR1116	15	±12	±63	30	140	20
PWR1117	15	±15	±50	30	140	20
PWR1118	24	5	300	30	90	20
PWR1119	24	12	125	30	90	20
PWR1120	24	15	100	30	90	20
PWR1121	24	±5	±150	30	90	20
PWR1122	24	±12	±63	30	90	20
PWR1123	24	±15	±50	30	90	20
PWR1140	5	9	167	30	400	45
PWR1141	12	9	167	30	175	25
PWR1142	15	9	167	30	140	20

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.5	5	5.5	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
		21.6	24	26.4	VDC
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60 Hz, 10 Seconds	500			Vpk
Resistance			10		GΩ
Capacitance			90		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		10		µArms
OUTPUT					
Rated Power			1.5		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{in}		±3	±5	%
Temperature Coefficient			±0.02		%/%°C
Ripple and Noise					
(BW = DC to 20MHz)	No External Components		150		mVp-p
	10µF Across Each Output		10		mVrms
	10µF Across Each Output		30		mVp-p
Voltage	No Load, V_{OUT} = +5V			7	VDC
	No Load, V_{OUT} = ±12V			±15	VDC
	No Load, V_{OUT} = ±15V			±18	VDC
Line Regulation			1.2		%/%V_{IN}
Load	No Load To Rated Load		6		%
GENERAL					
Switching Frequency			150		kHz
Package Weight			12		g
MTTF per MIL-HDBK-217 Rev. E*	Circuit Stress Method		800		kHr
Efficiency			75		%
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–40		+100	°C
Storage		–40		+110	°C

* For demonstrated MTTF results reference Burr-Brown Reliability Report PWR1205 (Literature Number PA647)

ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration	Momentary
Internal Power Dissipation	750mW
Lead Soldering Temperature (10 seconds max)	+300°C

ORDERING INFORMATION

PWR 11XX /H

Device Family
PWR Indicates DC/DC Converter

Model Number
Selected from Table of Electrical Characteristics

Screening Option

APPLICATION NOTE

UNBALANCED LOADS

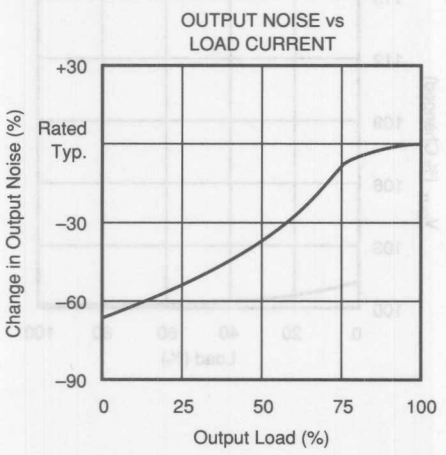
Unbalanced loads may be used on dual output models with either side providing up to its rated current. Output voltages, by design, will track each other in an unbalanced state within ±10% of one another.

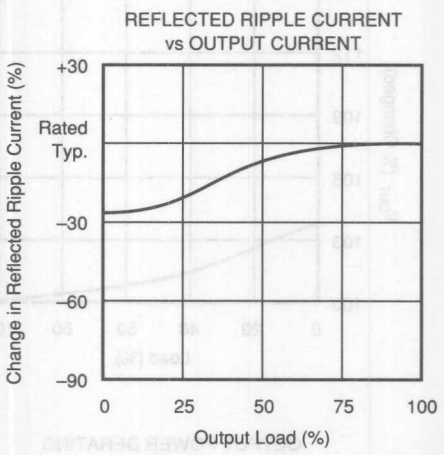
OUTPUT NOISE

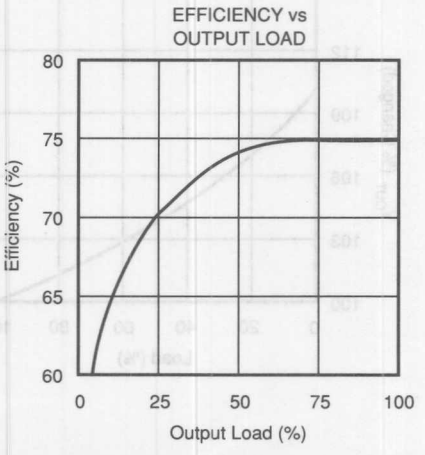
Output noise can be reduced to 30mVp-p, typically, by adding a 10µF tantalum capacitor with an equivalent series resistance (ESR) of less than 150mΩ at 10kHz across each output.

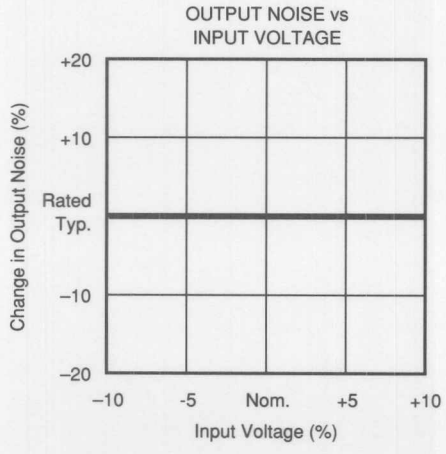
TYPICAL PERFORMANCE CURVES

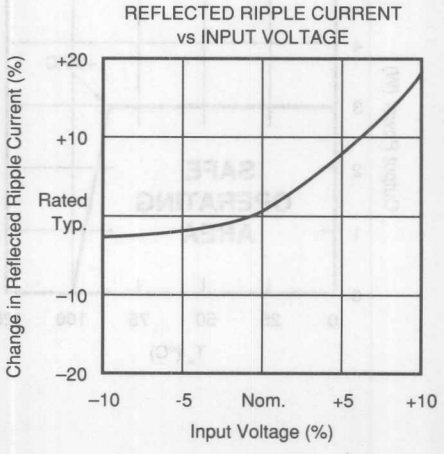
T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

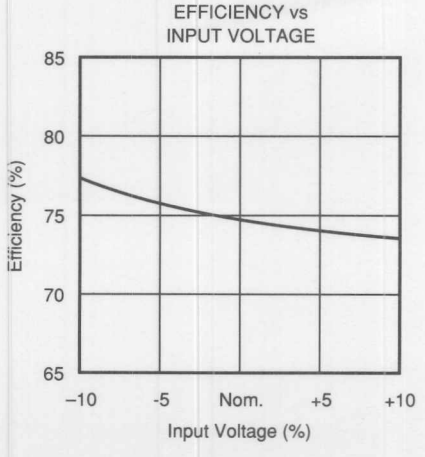








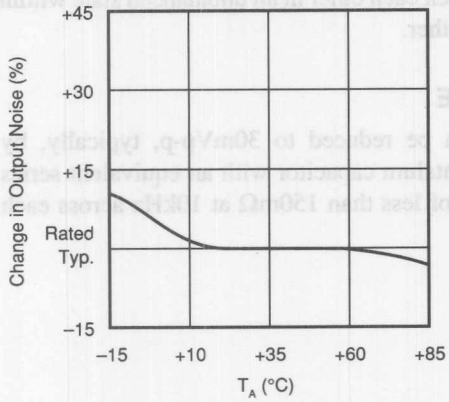




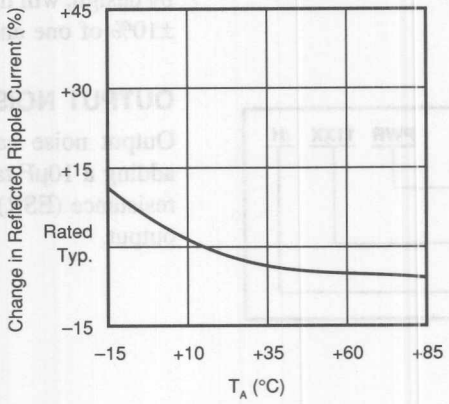
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

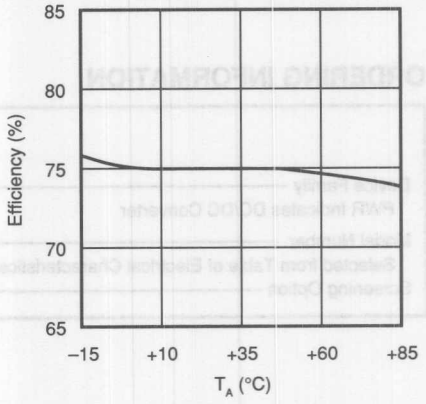
OUTPUT NOISE vs AMBIENT TEMPERATURE



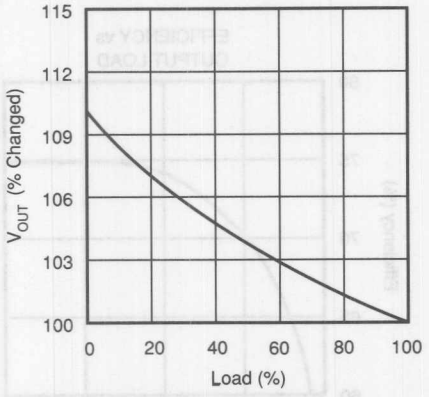
REFLECTED RIPPLE CURRENT vs AMBIENT TEMPERATURE



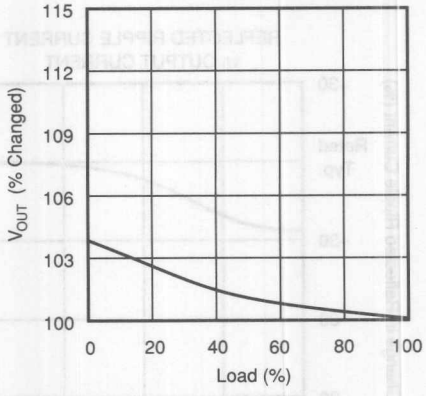
EFFICIENCY vs AMBIENT TEMPERATURE



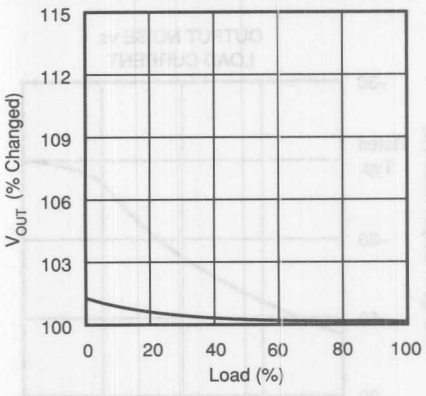
V_{OUT} vs LOAD ($5V_{OUT}$ MODELS)



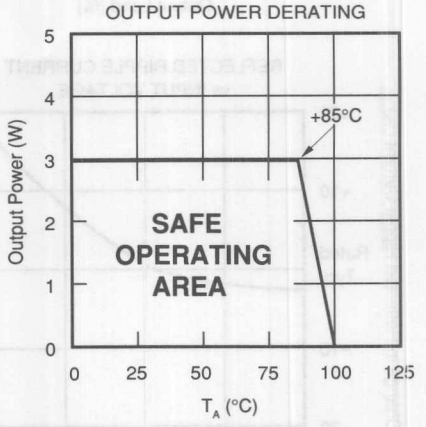
V_{OUT} vs LOAD ($\pm12V_{OUT}$ MODELS)



V_{OUT} vs LOAD ($\pm15V_{OUT}$ MODELS)



OUTPUT POWER DERATING



BURR-BROWN®

PWR13XX SERIES

1.5 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

4000V HIGH ISOLATION VOLTAGE RATING

FEATURES

- HIGH ISOLATION - 4000V RATING
- 8000V ISOLATION TEST VOLTAGE
- BARRIER 100% PRODUCTION TESTED
- LOW BARRIER CAPACITANCE - 10PF
- LOW LEAKAGE CURRENT - 2μA MAX
- 24-PIN DIP PACKAGE
- INTERNAL FILTERING

APPLICATIONS

- BIOMEDICAL DATA ACQUISITION
- INDUSTRIAL PROCESS CONTROL
- ANALYTICAL MEASUREMENTS
- GROUND LOOP ELIMINATION
- INTRINSIC SAFETY SYSTEMS

DESCRIPTION

The PWR13XX Series offers a broad line of low-cost, high-isolation voltage, unregulated, single and dual output DC/DC converters in a 24-pin DIP package. These small converters offer a 4000V isolation rating in a 1.25" x 0.8" package area.

The dielectric withstand characteristics of each converter is tested in production to ensure barrier integrity. During the development of the PWR13XX Series extensive testing was done to verify that subjecting the barrier to as many as ten barrier tests will not destroy the barrier.

The PWR13XX Series uses advanced circuit design and packaging technology to realize superior reliability and performance. A 220kHz driven push-pull oscillator is used to ensure stable frequency and non-saturating operation of the input stage. This means there are no high peak voltages or currents like other design topologies, which can reduce unit reliability. Reliability is further enhanced by the use of MOSPOWER transistors. These rugged devices permit higher frequency operation with less complicated drive circuitry than is possible with bipolar power transistors. Reduced parts count adds to the reliability of the PWR13XX Series.

The high efficiency of the PWR13XX Series means less internal power dissipation. With less heat to dissipate, the PWR13XX Series can operate over a wider ambient temperature range with no degradation of reliable operation.

The PWR13XX Series offers the user low cost without sacrificing reliability. The use of surface mounted devices and manufacturing technologies make it possible to offer premium performance and low cost. Testing of the PWR13XX isolation barrier is performed per the methods set forth by UL544, VDE750, CSA 22.2 and IEC 601-1.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise noted.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT NO LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)
PWR1300	5	5	300	50	400	30
PWR1301	5	12	125	50	400	30
PWR1302	5	15	100	50	400	30
PWR1303	5	±5	±150	50	400	30
PWR1304	5	±12	±63	50	400	30
PWR1305	5	±15	±50	50	400	30
PWR1306	12	5	300	30	167	25
PWR1307	12	12	125	30	167	25
PWR1308	12	15	100	30	167	25
PWR1309	12	±5	±150	30	167	25
PWR1310	12	±12	±63	30	167	25
PWR1311	12	±15	±50	30	167	25
PWR1312	15	5	300	30	133	20
PWR1313	15	12	125	30	133	20
PWR1314	15	15	100	30	133	20
PWR1315	15	±5	±150	30	133	20
PWR1316	15	±12	±63	30	133	20
PWR1317	15	±15	±50	30	133	20

Other input to output voltage options may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.5	5	5.5	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
ISOLATION					
Rated Voltage		4,000			VDC
Test Voltage	60 Hz, 60 Seconds	8,000			Vpk
Resistance			10		GΩ
Capacitance			10		pF
Leakage Current	V_{ISO}= 240VAC, 60Hz		1	2	µArms
OUTPUT					
Rated Power			1.5		Watts
Voltage Setpoint Accuracy	Rated Load, Nominal V_{in}			±5	%
Ripple & Noise	BW = DC to 10MHz		40		mVp-p
	BW = 10Hz to 2MHz		10		mVrms
REGULATION					
Line Regulation	High Line to Low Line		1.5		%/%
Load Regulation	See Performance Curves				
GENERAL					
Efficiency			75		%
Switching Frequency			220		kHz
Package Weight			12		g
MTTF per MIL-HDBK-217, Rev. E*	Circuit Stress Method				
Ground Benign	T_A = +25°C		2,000,000		Hr
	T_A = +85°C		90,000		Hr
Fixed Ground	T_A = +35°C		540,000		Hr
Naval Sheltered	T_A = +35°C		300,000		Hr
Airborne Uninhabited Fighter	T_A = +35°C		55,000		Hr
TEMPERATURE					
Specification		-40	+25	+85	°C
Operation		-55		+100	°C
Storage		-55		+110	°C

* For demonstrated MTTF results reference Burr-Brown Reliability Report PWR1304A (Literature Number PA744)

ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration	5 seconds
Internal Power Dissipation	750mW
Lead Temperature (soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

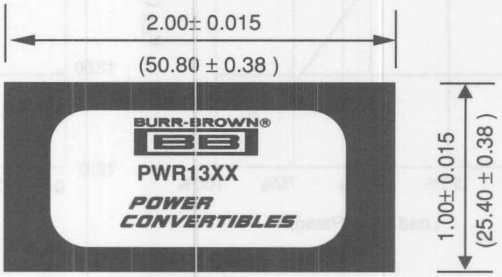
PWR 13XX A /H

- Device Family: PWR Indicates DC/DC Converter
- Model Number: Selected from Electrical Specifications Table
- Package Option: Choose From A or B
- Screening Option

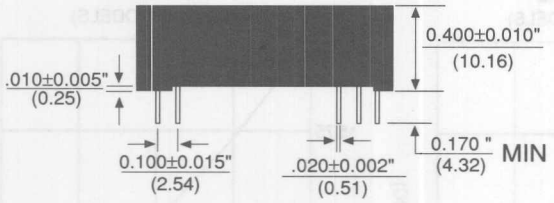
MECHANICAL SPECIFICATIONS

Top View - "A" Package Option

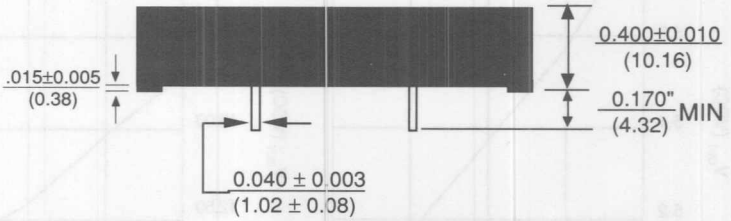
Top View - "B" Package Option



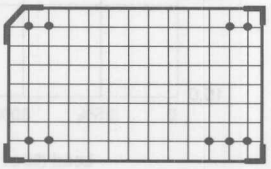
Side View - "A" Package Option



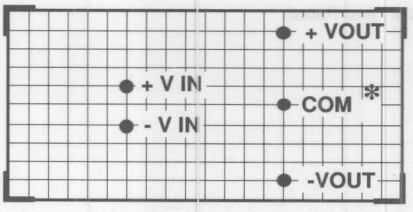
Side View - "B" Package Option



Bottom View - "A" Package Option



Bottom View - "B" Package Option



PIN CONNECTIONS

"A"Package Option Only

PIN	SINGLE MODELS	DUAL MODELS
1	$+V_{IN}$	$+V_{IN}$
2	$+V_{IN}$	$+V_{IN}$
11	$+V_{OUT}$	$+V_{OUT}$
12	$+V_{OUT}$	$+V_{OUT}$
13	$-V_{OUT}$	Common *
14	$-V_{OUT}$	Common *
15	No Pin	$-V_{OUT}$
23	$-V_{IN}$	$-V_{IN}$
24	$-V_{IN}$	$-V_{IN}$

Notes:

All dimensions are in inches (millimeters).

GRID: 0.100 inches (2.54 millimeters)

* Common pins not present on single output models.

PIN PLACEMENT TOLERANCE: ± 0.015"

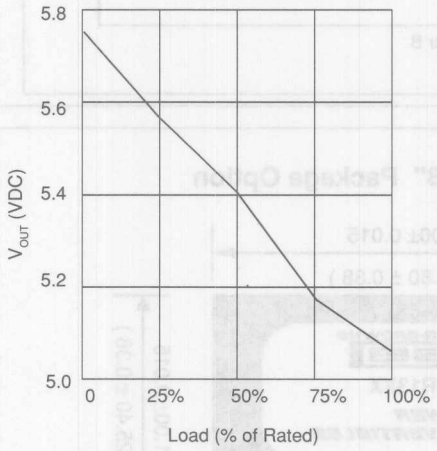
Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

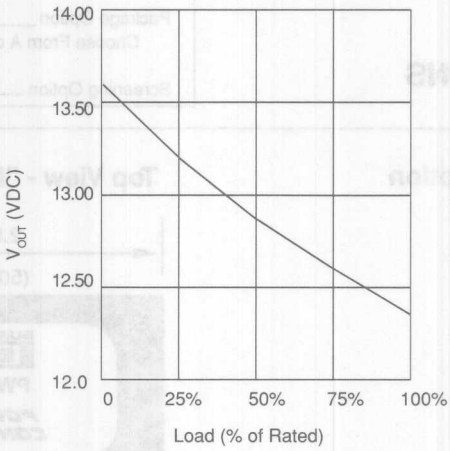
TYPICAL PERFORMANCE CURVES

Specifications at T_A = +25°C, nominal input voltage, rated output current

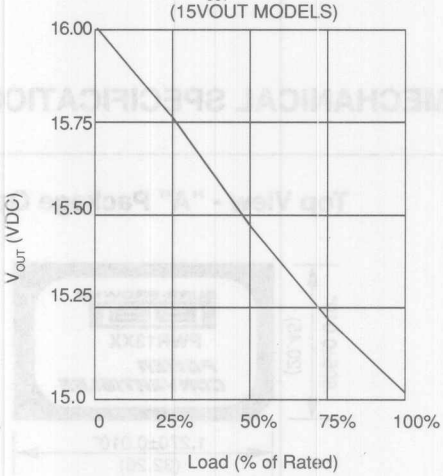
V_{OUT} VS LOAD
(5VOUT MODELS)



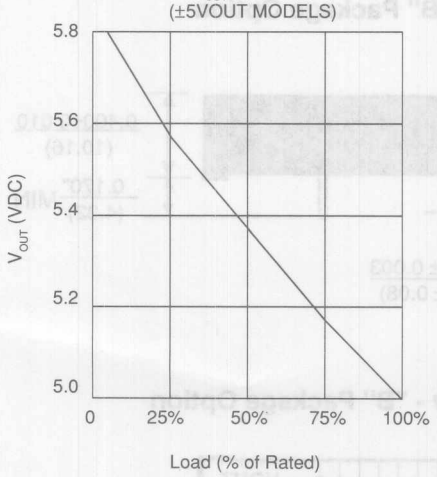
V_{OUT} VS LOAD
(12VOUT MODELS)



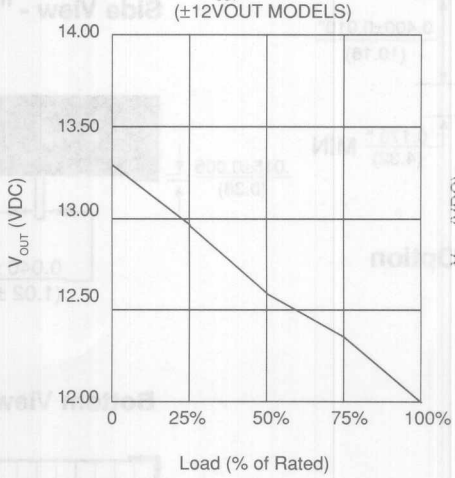
V_{OUT} VS LOAD
(15VOUT MODELS)



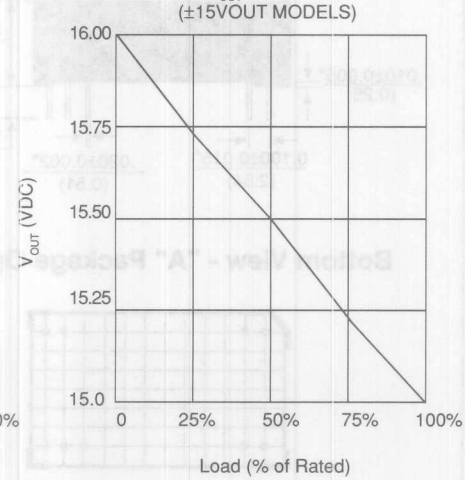
V_{OUT} VS LOAD
(±5VOUT MODELS)



V_{OUT} VS LOAD
(±12VOUT MODELS)



V_{OUT} VS LOAD
(±15VOUT MODELS)



BURR-BROWN®

PWR1726 SERIES

1.5 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

HIGH ISOLATION VOLTAGE

FEATURES

- 8000V ISOLATION TEST VOLTAGE
- NO EXTERNAL PARTS REQUIRED
- SYNCHRONIZABLE
- REMOTE ON/OFF
- LOW-BARRIER CAPACITANCE

APPLICATIONS

- MEDICAL EQUIPMENT
- INDUSTRIAL PROCESS EQUIPMENT
- DATA ACQUISITION
- TEST EQUIPMENT
- PORTABLE EQUIPMENT

DESCRIPTION

The PWR1726 is a single-channel, dual-output DC/DC converter designed for those applications where high-isolation voltage and low-barrier capacitance are critical for system reliability and integrity.

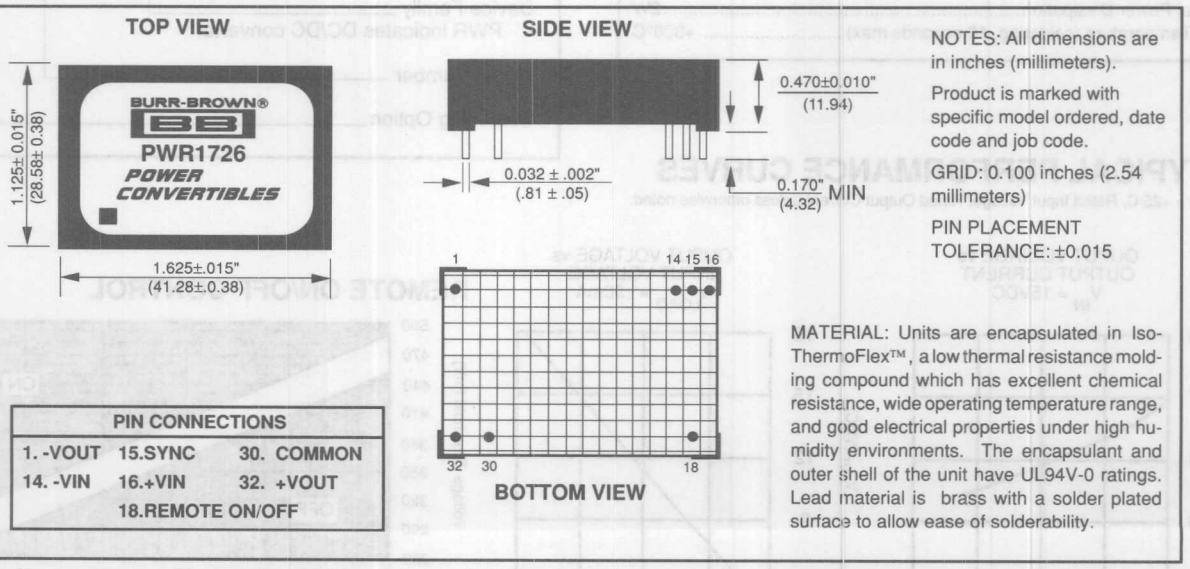
Calculated mean-time-to-failure (MTTF) is in excess of 100 years at an ambient temperature of +25°C and at rated output power. The performance of the PWR1726 is not derated over its entire specified temperature range of -25°C to +85°C.

Synchronization of the PWR1726 may be accomplished simply by connecting the Sync pin of one unit to the Sync pin of another unit. In this manner, up to eight converters may be ganged together.

The PWR1726 provides a plus and minus output voltage that is approximately equal to the magnitude of the input voltage. The PWR1726 operates over an input voltage range of 7VDC to 18VDC.

Each PWR1726 is tested with UL544, VDE750, and CSA C22.2 dielectric withstand methods.

MECHANICAL



NOTES: All dimensions are in inches (millimeters).

Product is marked with specific model ordered, date code and job code.

GRID: 0.100 inches (2.54 millimeters)

PIN PLACEMENT TOLERANCE: ±0.015

PIN CONNECTIONS		
1. -VOUT	15.SYNC	30. COMMON
14. -VIN	16.+VIN	32. +VOUT
	18.REMOTE ON/OFF	

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

SPECIFICATIONS

ELECTRICAL

Specifications typical at T_A = +25°C, V_{IN} = 15VDC, I_{LOAD} = ±50mA and in free-running mode unless otherwise noted.

PARAMETER	CONDITIONS	PWR1726 MIN	PWR1726 TYP	PWR1726 MAX	UNITS
INPUT					
Rated Voltage			15		VDC
Voltage Range		7		18	VDC
Input Current	I_{LOAD} = 0		30		mA
	I_{LOAD} = Rated Load		145	165	mA
	Short Circuit		115		mA
Ripple Current	I_{LOAD} = Rated Load		15		mAp-p
ISOLATION					
Voltage Rated Continuous					
AC, 60Hz		3500			Vrms
DC		5000			VDC
Test Voltage	60sec, 60Hz	8000			Vpk
Resistance			10		GΩ
Capacitance			10		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		1	2	µA
OUTPUT					
Rated Voltage	I_{LOAD} = Rated Load		±15		VDC
Voltage Range	I_{LOAD} Rated Load	±14.25		±15.75	VDC
	I_{LOAD} = OmA	±16.0	±16.5	±18.0	VDC
Rated Current	Balanced Loads		±50		mA
Current Range	Balanced Loads	0		±90	mA
	Single Ended	0		180	mA
Line Regulation	7VDC < V_{IN} < 18VDC		1.16		mV/mV
Load Regulation	No Load < I_{OUT} < ±50mA			0.3	%/mA
Ripple Voltage	BW = DC to 10MHz				
	I_{LOAD} = 0		15		mVp-p
	I_{LOAD} = Rated Load		50		mVp-p
GENERAL					
MTTF	Calculated per MIL - HDBK - 217 Rev. E Ground, Benign 25° C		1.2		MHr
Switching Frequency			120		kHz
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–40		+100	°C
Storage		–55		+125	°C

NOTE: Other input and output voltages may be available upon request. Please consult factory.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	18VDC
Output Short-Circuit Duration	Continuous
Internal Power Dissipation	2W
Lead Temperature (soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

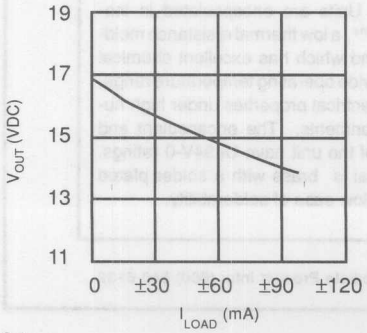
PWR 1726 /H

- Device Family: PWR indicates DC/DC converter
- Model Number
- Screening Option

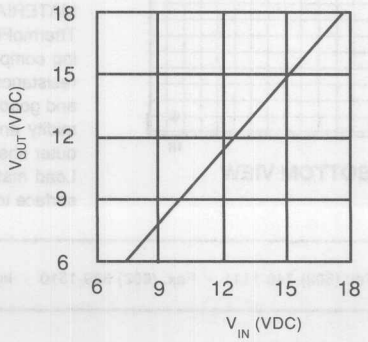
TYPICAL PERFORMANCE CURVES

TA = +25 C, Rated Input Voltage, Rated Output Current unless otherwise noted.

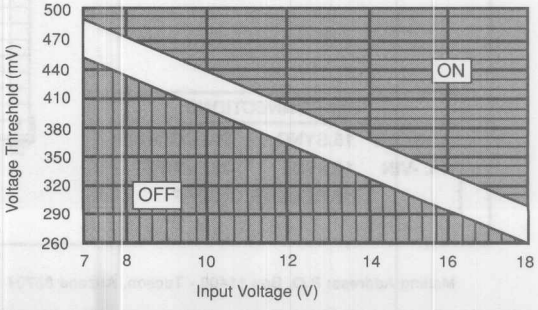
OUPUT VOLTAGE vs OUTPUT CURRENT
V_{IN} = 15VDC



OUPUT VOLTAGE vs INPUT VOLTAGE
I_{LOAD} = ±50mA



REMOTE ON/OFF CONTROL



BURR-BROWN®

PWR60XX SERIES

1.8 WATTS
REGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

INDUSTRY STANDARD PACKAGE

FEATURES

- LOW COST
- LOW NOISE
- INDUSTRY-STANDARD PACKAGE
- SINGLE AND DUAL OUTPUTS
- HIGH ISOLATION VOLTAGE OPTION AVAILABLE
- LINEAR OUTPUT REGULATION
- INTERNAL INPUT AND OUTPUT FILTERING
- LOW EMI TRANSFORMER DESIGN
- NO EXTERNAL COMPONENTS REQUIRED
- THERMAL SHUTDOWN PROTECTION

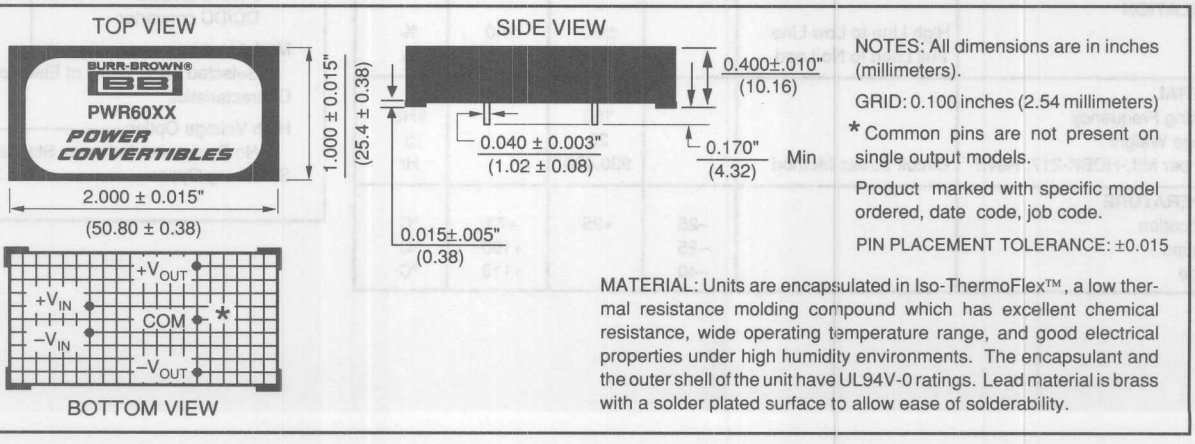
DESCRIPTION

The PWR60XX Series offers a low-cost alternative for some of the most popular DC/DC converters industry wide. Each model has very low noise and an outstanding MTTF. The superior reliability, excellent filtering, and low cost make it an excellent choice for industry-standard usage.

The series includes eleven models (other input and output voltages are available upon request), all set in Iso-ThermoFlex™ encapsulant for excellent thermal dissipation for internal components. The use of surface-mount devices and manufacturing processes combined with the encapsulation process, provides the user a product that is more environmentally rugged.

The PWR60XX has full isolation between input and output to give the designer maximum flexibility in grounding options and polarity configurations. The outputs are protected against shorts to increase the units survivability in harsh environments.

MECHANICAL



NOTES: All dimensions are in inches (millimeters).

GRID: 0.100 inches (2.54 millimeters)

* Common pins are not present on single output models.

Product marked with specific model ordered, date code, job code.

PIN PLACEMENT TOLERANCE: ±0.015

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and the outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, rated input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE	RATED OUTPUT VOLTAGE	RATED OUTPUT CURRENT	INPUT CURRENT NO LOAD	INPUT CURRENT RATED LOAD	REFLECTED RIPPLE CURRENT	EFFICIENCY
UNITS	VDC	VDC	mA	mA	mA	mAp-p	%
PWR6000	5	5	360	70	655	15	55
PWR6004	5	±12	±75	70	570	15	63
PWR6005	5	±15	±60	70	555	15	65
PWR6006	12	5	360	30	275	10	55
PWR6010	12	±12	±75	30	240	10	63
PWR6011	12	±15	±60	30	230	10	65
PWR6012	15	5	360	25	220	8	55
PWR6016	15	±12	±75	25	190	8	63
PWR6017	15	±15	±60	25	185	8	65
PWR6018	24	5	360	13	120	12	62
PWR6023	24	±15	±60	13	120	12	62

NOTE: Other input to output voltages may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, rated input voltage, rated output current unless otherwise specified.

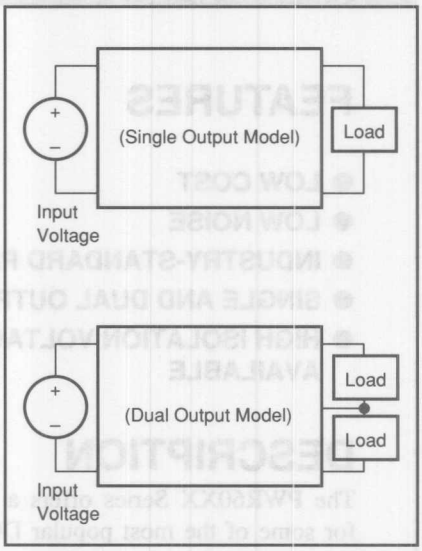
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT	PWR6000	4.65	5.0	5.5	VDC
	PWR6004	4.65	5.0	5.5	VDC
	PWR6005	4.65	5.0	5.5	VDC
	PWR6006	10.9	12.0	13.2	VDC
	PWR6010	10.9	12.0	13.2	VDC
	PWR6011	10.9	12.0	13.2	VDC
	PWR6012	13.9	15.0	16.5	VDC
	PWR6016	13.9	15.0	16.5	VDC
	PWR6017	13.9	15.0	16.5	VDC
	PWR6018	21.6	24	26.4	VDC
	PWR6023	21.6	24	26.4	VDC
ISOLATION (Standard)					
Rated Voltage		500			VDC
Test Voltage		500			Vpk
Resistance			10		GΩ
Capacitance			27		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz			5	µArms
ISOLATION (–HV Option)					
Rated Voltage		1000			VDC
Test Voltage		3000			Vpk
Resistance			10		GΩ
Capacitance			27		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz			5	µArms
OUTPUT					
Rated Power	–25°C ≤ T_A ≤ +70°C		1.8		Watts
Voltage Setpoint Accuracy	Rated Load, Nominal Vin			±2	%
Temperature Coefficient			±0.01		%/°C
Ripple and Noise	BW = DC to 10MHz		20	45	mVp-p
REGULATION					
Line	High Line to Low Line		±0.2	±1.0	%
Load	Full Load to No Load		0.5	1.0	%
GENERAL					
Switching Frequency			150		kHz
Package Weight			20		g
MTTF per MIL-HDBK-217, RevE	Circuit Stress Method		930,000		Hr
TEMPERATURE					
Specification		–25	+25	+70	°C
Operation		–25		+100	°C
Storage		–40		+110	°C

ABSOLUTE MAXIMUM RATINGS

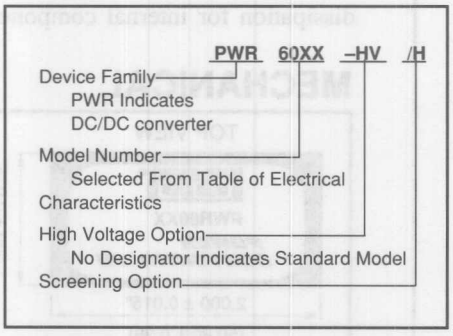
Output Short-Circuit Duration
- Outputs to Common ..... Continuous
- Output to Output ..... Momentary

Output Power 2.0W
Lead Temperature ..... +300°C
(soldering, 10 seconds max)

TYPICAL APPLICATIONS



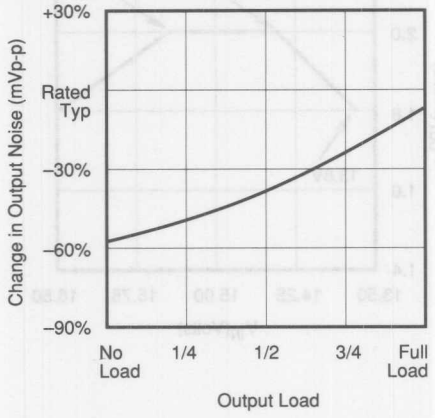
ORDERING INFORMATION



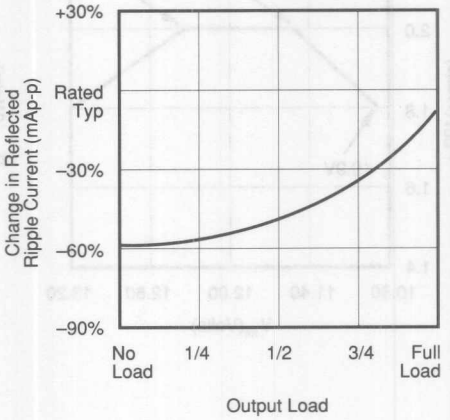
TYPICAL PERFORMANCE CURVES

T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

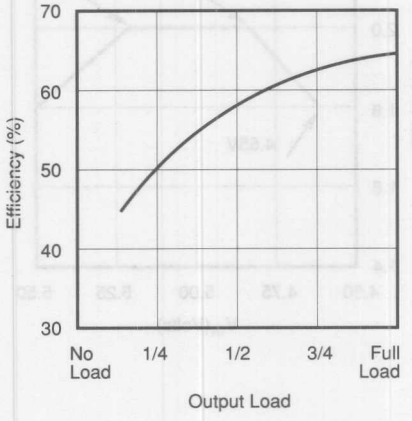
OUTPUT NOISE vs LOAD CURRENT



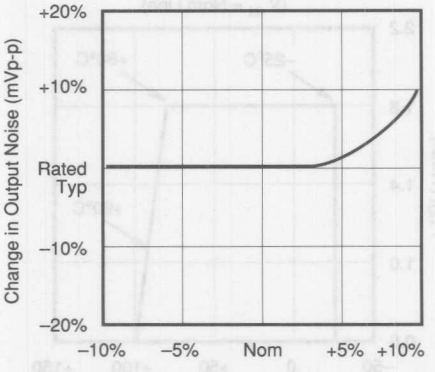
REFLECTED RIPPLE CURRENT vs OUTPUT CURRENT



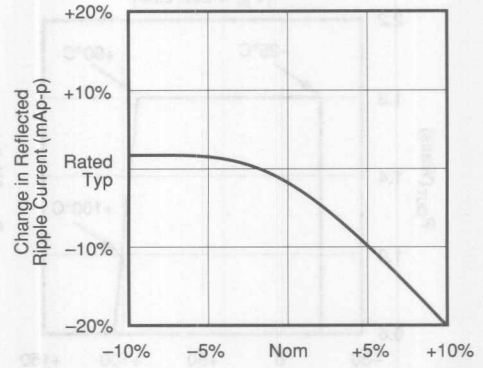
EFFICIENCY vs OUTPUT LOAD



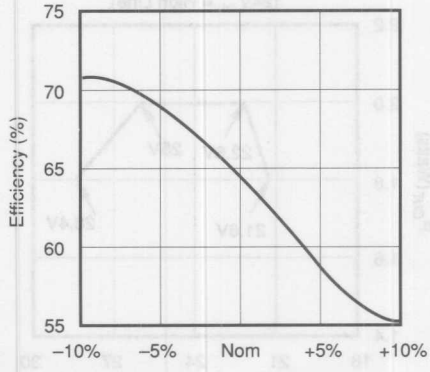
OUTPUT NOISE vs LOAD CURRENT



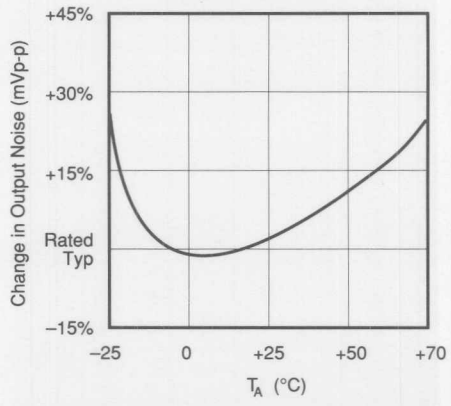
REFLECTED RIPPLE CURRENT vs INPUT CURRENT



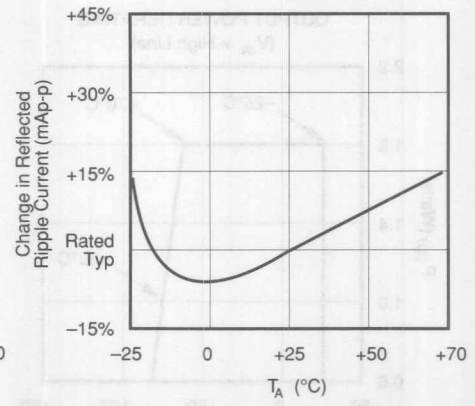
EFFICIENCY vs INPUT LOAD



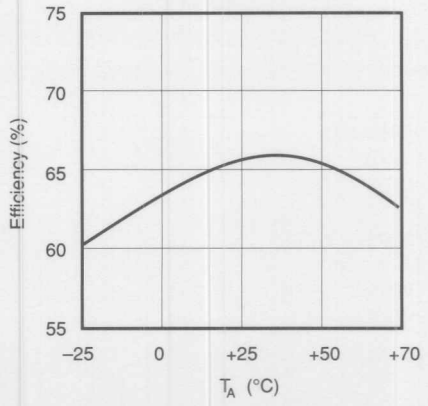
OUTPUT NOISE vs AMBIENT TEMPERATURE



REFLECTED RIPPLE CURRENT vs AMBIENT TEMPERATURE



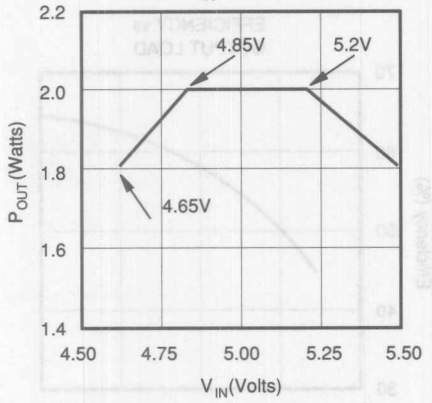
EFFICIENCY vs AMBIENT TEMPERATURE



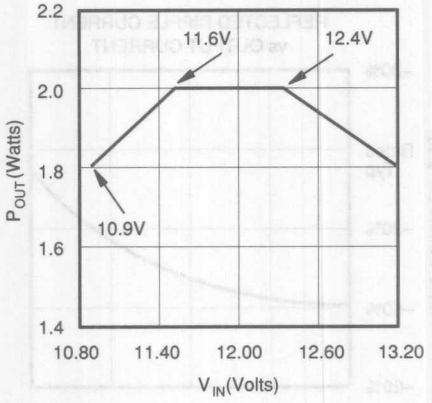
TYPICAL PERFORMANCE CURVES

T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

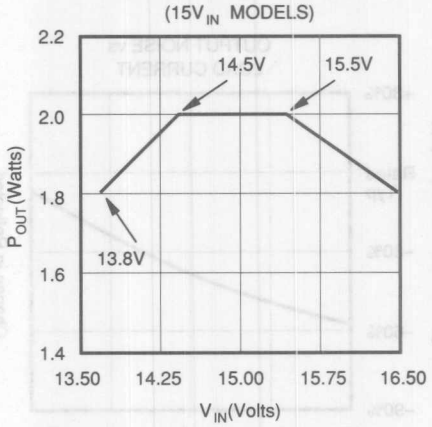
OUTPUT POWER DERATING
($5V_{IN}$ MODELS)



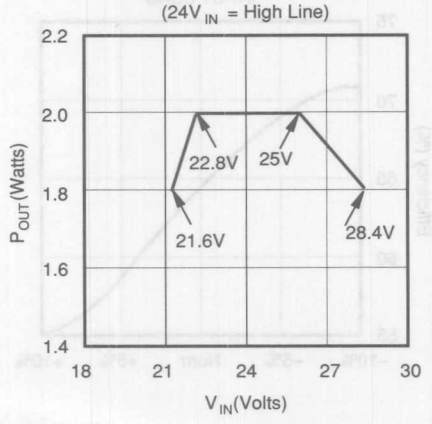
OUTPUT POWER DERATING
($12V_{IN}$ MODELS)



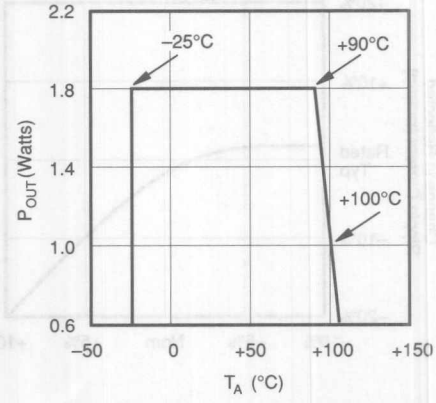
OUTPUT POWER DERATING
($15V_{IN}$ MODELS)



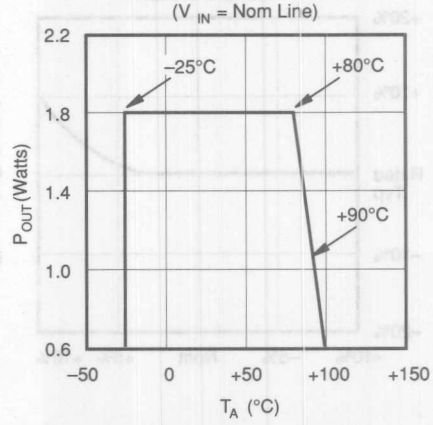
OUTPUT POWER DERATING
($24V_{IN}$ = High Line)



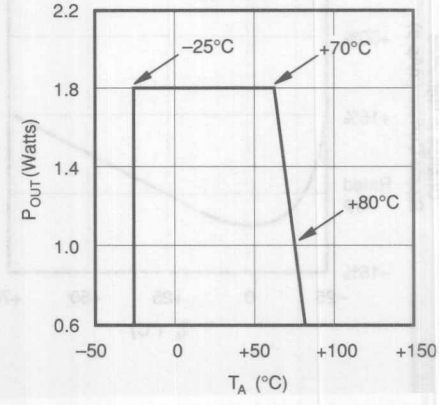
OUTPUT POWER DERATING
(V_{IN} = Low Line)



OUTPUT POWER DERATING
(V_{IN} = Nom Line)



OUTPUT POWER DERATING
(V_{IN} = High Line)



BURR-BROWN®

PWR3XX SERIES

2 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

TWO CHANNEL, HIGH ISOLATION

FEATURES

- BARRIER LEAKAGE CURRENT 100% TESTED AT 240VAC
- 3000V ISOLATION TEST VOLTAGE
- SINGLE OR DUAL UNREGULATED OUTPUTS
- WIDE OPERATING TEMPERATURE RANGE: -40°C TO +100°C
- INPUT AND OUTPUT FILTERING
- SIX-SIDED SHIELDING

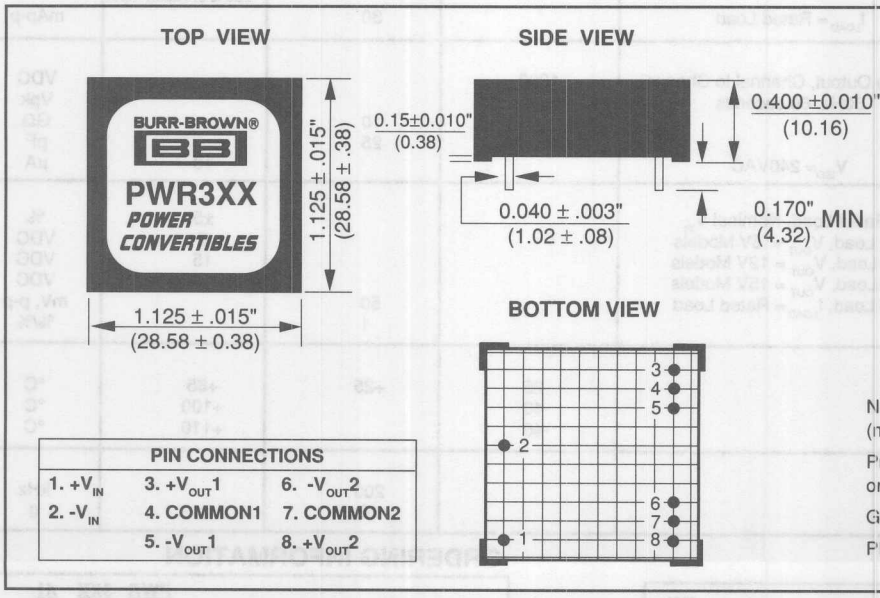
DESCRIPTION

The PWR3XX Series offers a large selection of unregulated 2W DC/DC converters for use in such diverse applications as process control, telecommunications, portable equipment, medical systems, airborne and shipboard electronic circuits, and automatic test equipment.

Thirty-six models allow the user to select input voltages of 5 VDC to 48 VDC and output voltages of 5, 12, 15, ±5, ±12, or ±15VDC.

Surface-mounted devices and manufacturing processes are used in the PWR3XX Series to provide the user a device that is environmentally rugged. The use of surface-mount technologies also gives the PWR3XX Series superior isolation voltage. Each PWR3XX Series unit is tested with the dielectric withstand voltage methods of UL544, VDE750, and CSA C22.2

MECHANICAL



PIN CONNECTIONS		
1. $+V_{IN}$	3. $+V_{OUT}1$	6. $-V_{OUT}2$
2. $-V_{IN}$	4. COMMON1	7. COMMON2
	5. $-V_{OUT}1$	8. $+V_{OUT}2$

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

NOTES: All dimensions are in inches (millimeters).

Product is marked with specific model ordered, date code and job code.

GRID: 0.100 inches (2.54 millimeters)

PIN PLACEMENT TOLERANCE: ±0.015

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	MAXIMUM INPUT CURRENT (mA)
PWR300	5	5	200	690
PWR301	5	12	84	690
PWR302	5	15	67	690
PWR303	5	±5	±100	690
PWR304	5	±12	±42	690
PWR305	5	±15	±34	690
PWR306	12	5	200	265
PWR307	12	12	84	265
PWR308	12	15	67	265
PWR309	12	±5	±100	265
PWR310	12	±12	±42	265
PWR311	12	±15	±34	265
PWR312	15	5	200	205
PWR313	15	12	84	205
PWR314	15	15	67	205
PWR315	15	±5	±100	205
PWR316	15	±12	±42	205
PWR317	15	±15	±34	205
PWR318	24	5	200	130
PWR319	24	12	84	130
PWR320	24	15	67	130
PWR321	24	±5	±100	130
PWR322	24	±12	±42	130
PWR323	24	±15	±34	130
PWR324	28	5	200	115
PWR325	28	12	84	115
PWR326	28	15	67	115
PWR327	28	±5	±100	115
PWR328	28	±12	±42	115
PWR329	28	±15	±34	115
PWR330	48	5	200	70
PWR331	48	12	84	70
PWR332	48	15	67	70
PWR333	48	±5	±100	70
PWR334	48	±12	±42	70
PWR335	48	±15	±34	70

Note: Other input to output voltage options may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range				±20% of Rated Input	
Input Ripple Current	I_{LOAD} = Rated Load		30		mAp-p
ISOLATION					
Rated Voltage	Input to Output, Channel to Channel	1000			VDC
Test Voltage	60Hz, 60 seconds	3000			Vpk
Resistance			10		GΩ
Capacitance			25		pF
Leakage Current	V_{ISO} = 240VAC			10	µA
OUTPUT					
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Voltage	No Load, V_{OUT} = 5V Models			7	VDC
	No Load, V_{OUT} = 12V Models			15	VDC
	No Load, V_{OUT} = 15V Models			18	VDC
Ripple Voltage	No Load, I_{LOAD} = Rated Load		50		mV, p-p
Line Regulation			1		%/%
TEMPERATURE					
Specification			+25		°C
Operation		-25		+85	°C
Storage		-40		+100	°C
		-40		+110	°C
GENERAL					
Switching Frequency			200		kHz
Package Weight			16		g

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....2W
Output Short-Circuit Duration.....Continuous to Output Common
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

PWR 3XX /H

Device Family
PWR Indicates DC/DC Converter
Model Number
Selected From Table Above
Screening Option

BURR-BROWN®

LPR3XX SERIES

2.25 WATTS UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

DUAL-IN-LINE PACKAGE; LOCAL AREA NETWORK (LAN) APPLICATIONS

FEATURES

- 24-PIN DIP PACKAGE
- INTERNAL FILTERING
- LOW OUTPUT NOISE
- TEMPERATURE RANGE
  -25°C TO +70°C
- SURFACE MOUNT CONSTRUCTION

APPLICATIONS

- ETHERNET ADAPTER CARDS
- CHEAPERNET LOCAL AREA NETWORKS

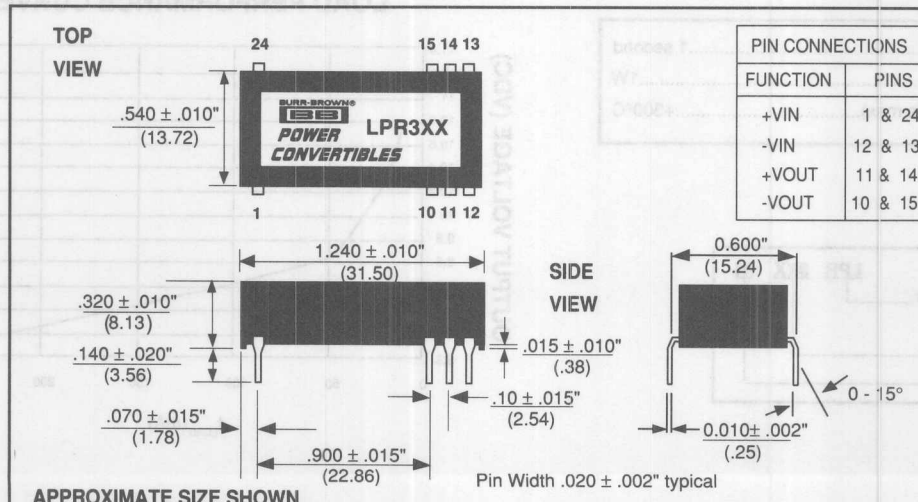
DESCRIPTION

The LPR3XX Series is designed specifically for high-volume, low-cost Local Area Network applications. It provides isolated power for LAN transceiver devices. The Series operates from either 5 or 12 volts input voltage and supplies an isolated -9 volts output.

The LPR3XX Series is housed in an industry standard 24-pin dual-in-line (DIP) package to permit upgrading of existing systems. A 150kHz push-pull oscillator is used in the input stage, complementing the units high-efficiency and low-noise characteristics.

The LPR3XX Series offers the user low cost without sacrificing reliability. The use of surface mounted devices and manufacturing technologies make it possible to provide premium performance and low cost.

MECHANICAL



PIN CONNECTIONS	
FUNCTION	PINS
+VIN	1 & 24
-VIN	12 & 13
+VOUT	11 & 14
-VOUT	10 & 15

NOTES: All dimensions are in inches (millimeters).

Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is phosphor bronze with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT NO LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)
LPR340	5	9	250	75	633	45	70
LPR341	12	9	250	75	275	30	67

NOTE: Other input to output voltage options may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range	LPR340	4.75	5	5.25	VDC
	LPR341	11.4	12	12.6	VDC
Voltage Rise Time	See Application Note: "Capacitive Loading Effects on Start-Up of DC/DC Converters				
ISOLATION					
Rated Voltage		500			Vrms
Test Voltage	60Hz, 10 Seconds	500			Vpk
Resistance			1		GΩ
Capacitance			30		pF
OUTPUT					
Rated Power			2.25		W
Voltage Setpoint Accuracy	I_{LOAD} =200mA		±3		%
Ripple & Noise	BW = DC to 10MHz		30		mVp-p
	BW =DC to 2MHz		3		mVrms
Line Regulation	High Line to Low Line		1.15		%/%
Load Regulation	25mA≤I_{LOAD} ≤200mA		±10		%
GENERAL					
Switching Frequency			150		kHz
Package Weight			6		g
MTTF per MIL-HDBK-217, Rev. E	Circuit Stress Method				
Ground Benign	T_A = +25°C		3,000		kHr
	T_A = +70°C		700		kHr
TEMPERATURE					
Specification		-25	+25	+70	°C
Operation		-55		+85	°C
Storage		-55		+100	°C

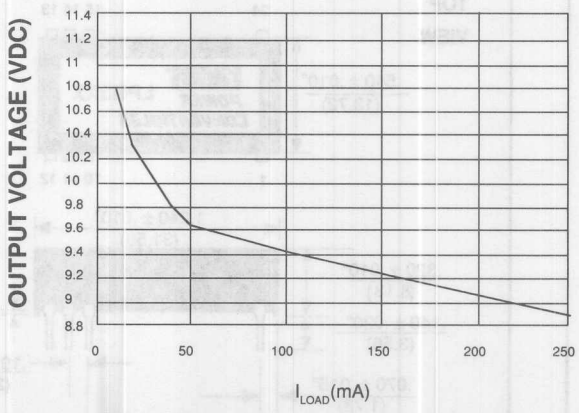
ABSOLUTE MAXUMUM RATINGS

Output Short-Circuit Duration.....1 second
Internal Power Dissipation 1W
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

Device Family — LPR
LPR Indicates LAN DC/DC Converter
Model Number — 3XX
Selected From Table Above
Screening Option — /H

LOAD PERFORMANCE CURVE



BURR-BROWN®

PWR1017 SERIES

3 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

FOUR CHANNEL, DUAL-OUTPUT

FEATURES

- SYNCHRONIZABLE
- ALL OUTPUTS ISOLATED
- OUTPUT POWER TO 3W
- HIGH ISOLATION VOLTAGE: 1kVDC
- SIX-SIDED SHIELDING
- INPUT AND OUTPUT FILTERING
- LOW PROFILE PACKAGE: 0.4" HIGH

APPLICATIONS

- POWER FOR HIGH RESOLUTION DATA ACQUISITION
- PRECISION TEST EQUIPMENT
- PROCESS CONTROL
- PORTABLE EQUIPMENT
- MULTIPLE POWER SUPPLIES

DESCRIPTION

The PWR1017 is a four-channel, dual-output unregulated DC/DC converter designed for low noise applications where high efficiency and switching synchronization are required.

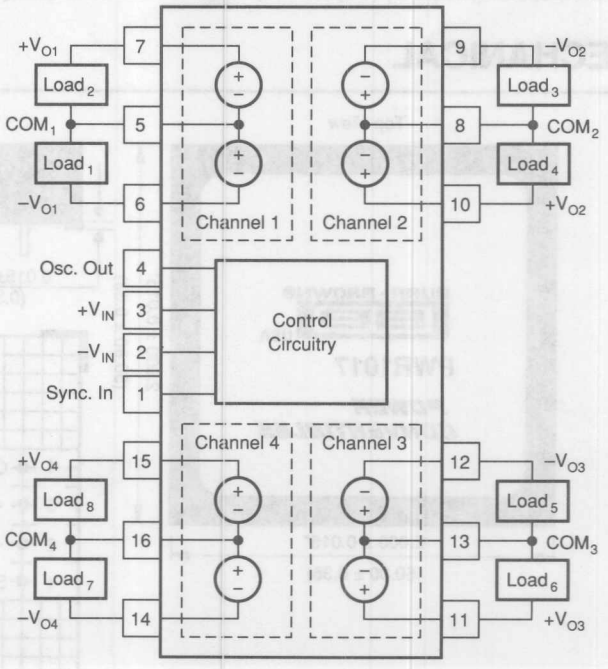
Any unit whose slave pin is connected to another unit's master pin will cause the oscillators to lock together. The PWR1017 may also be driven from a system master clock. The free-running switching frequency is 250kHz.

The PWR1017 has four isolated plus and minus output voltages approximately equal to the magnitude of the input voltage. It operates over an input voltage range of 10VDC to 18VDC. Rated output current for the PWR1017 is 25mA for each output.

Isolation voltage between the input and any of the four output channels is 1kVDC continuous. The same isolation specification applies between any of the four dual outputs.

Six-sided shielding suppresses electromagnetic radiation, which could disturb sensitive analog measurements or interfere with system timing signals. Filtering the PWR1017 input and outputs minimizes the effects of electrical noise on the source and loads of the converter.

Each PWR1017 is tested with UL544, VDE750, and CSA C22.2 dielectric withstand methods. In addition, barrier leakage current is 100% tested.



Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

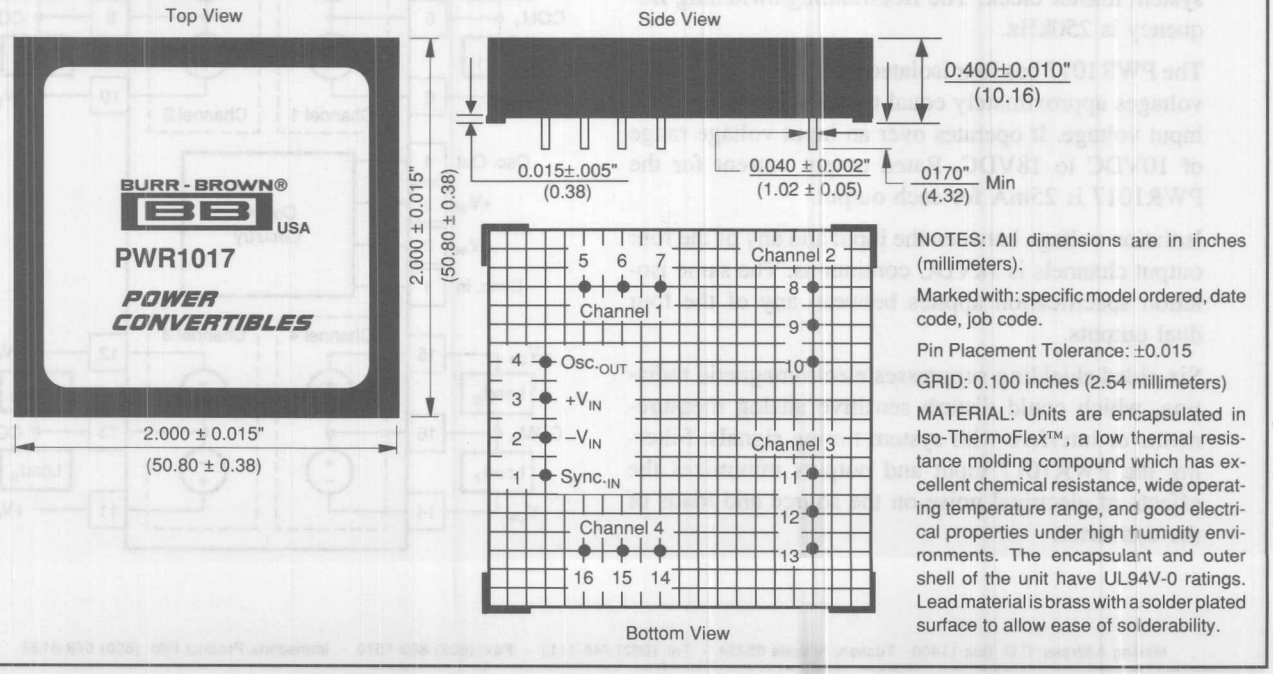
ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = 25°C, V_{IN} = 15VDC, I_{LOAD} = ±25mA and in free-running mode unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Rated Voltage			15		VDC
Voltage Range		10		18	VDC
Input Current	I_{LOAD} = 0		70		mA
	I_{LOAD} = Rated Load		285	350	mA
Ripple Current	I_{LOAD} = Rated Load		80		mAp-p
ISOLATION	Rating Applies Input-to-Output and Channel-to-Channel				
Rated Voltage		1000			VDC
Test Voltage	60Hz, 60 Seconds	3000			Vpk
Resistance			10		GΩ
Capacitance			15		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		0.9	3	µA
OUTPUT					
Rated Voltage			±15		VDC
Voltage Range	I_{LOAD} = 0mA		±16.5	±18	VDC
	I_{LOAD} = Rated Load	±14.25		±15.75	VDC
Rated Current	Each Output			±25	mA
	Total of All Outputs			200	mA
Current Range	Each Output	0		±40	mA
	Total of All Outputs	0		500	mA
Line Regulation	10VDC < V_{IN} < 18VDC		1.16		mV/mV
Load Regulation	0 > I_{LOAD} > 25mA		12.5		mV/mA
Ripple Voltage	I_{LOAD} = 0		±10		mVpk
	I_{LOAD} = Rated Load			±100	mVpk
SYNCHRONIZATION(1)					
f_{SYNC} Range	V_{SYNC} > 6.4Vp-p	400		700	kHz
V_{SYNC} Range	400kHz < f_{SYNC} < 700kHz	6.4		36	Vp-p
Oscillator Output Fanout				2	Sync Inputs
V_{SYNC}, Max	Max Deviation From $-V_{IN}$			50	V
V_{SYNC} Duty Cycle		5	50	60	%
GENERAL					
Switching Frequency			250		kHz
Package Weight			50		g
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–40		+100	°C
Storage		–55		+125	°C

NOTE: (1) Operating frequency (in sync mode) = f_{SYNC}/ 2. Oscillator frequency (pin 4, sync mode) = f_{SYNC}.

MECHANICAL



NOTES: All dimensions are in inches (millimeters).

Marked with: specific model ordered, date code, job code.

Pin Placement Tolerance: ±0.015

GRID: 0.100 inches (2.54 millimeters)

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

ORDERING INFORMATION

PWR 1017 /H

Device Family
PWR indicates DC/DC converter
Model Number
Screening Option

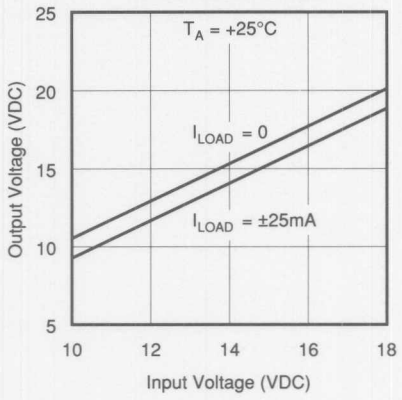
ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation	5.6W
Lead Temperature (soldering, 10 seconds max)	+300°C
Output Short Circuit Duration	Momentary

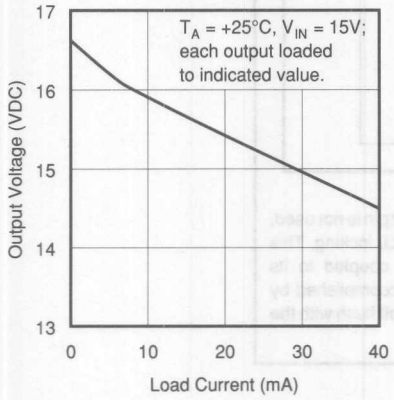
TYPICAL PERFORMANCE CURVES

At T_A = +25°C, Nominal Vin, Rated Load free running operation unless otherwise noted.

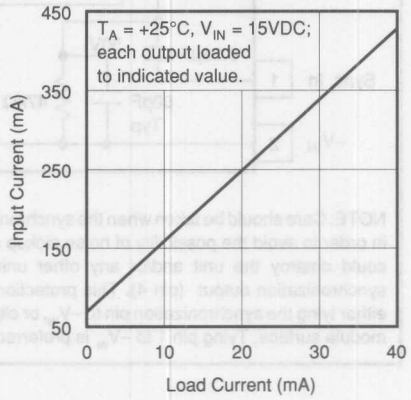
INPUT VOLTAGE vs OUTPUT VOLTAGE



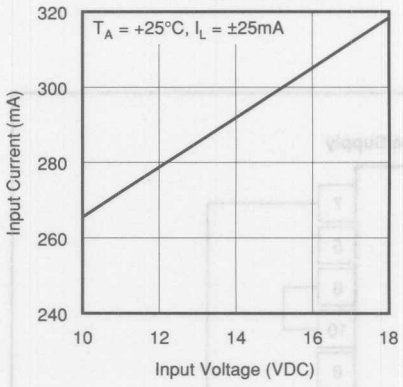
OUTPUT VOLTAGE vs LOAD CURRENT



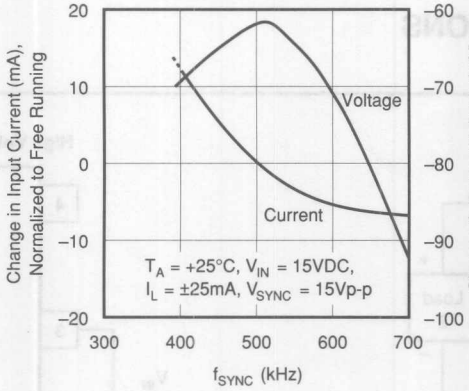
INPUT CURRENT vs OUTPUT CURRENT



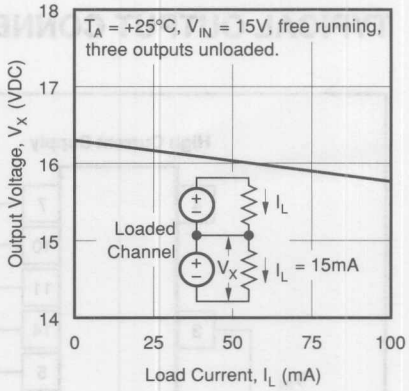
INPUT CURRENT vs INPUT VOLTAGE



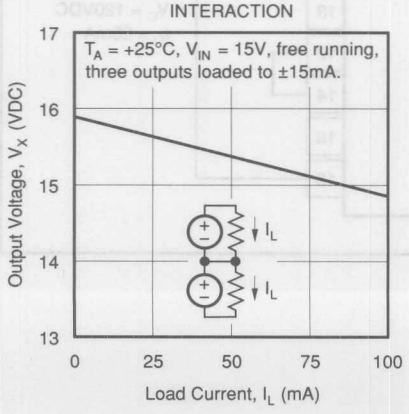
f_{SYNC} vs INPUT CURRENT AND OUTPUT VOLTAGE



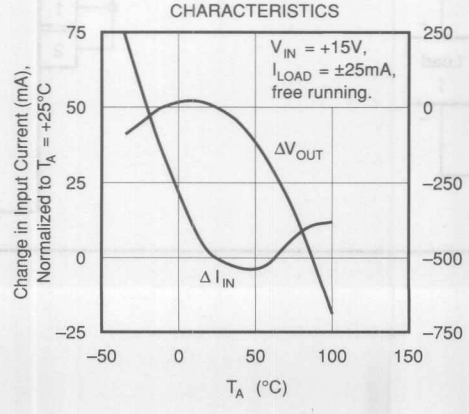
OUTPUT-TO-OUTPUT INTERACTION



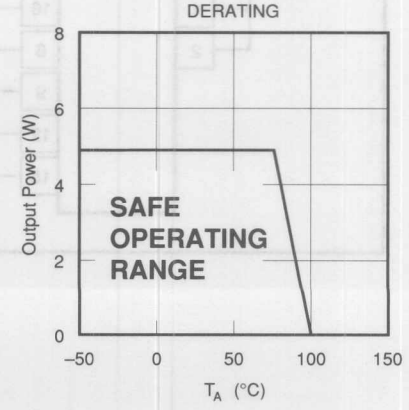
CHANNEL-TO-CHANNEL INTERACTION



TEMPERATURE CHARACTERISTICS

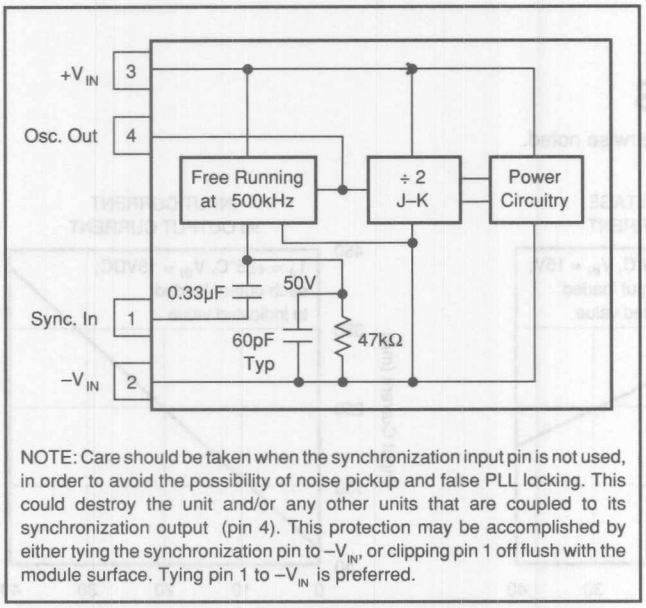


OUTPUT POWER DERATING



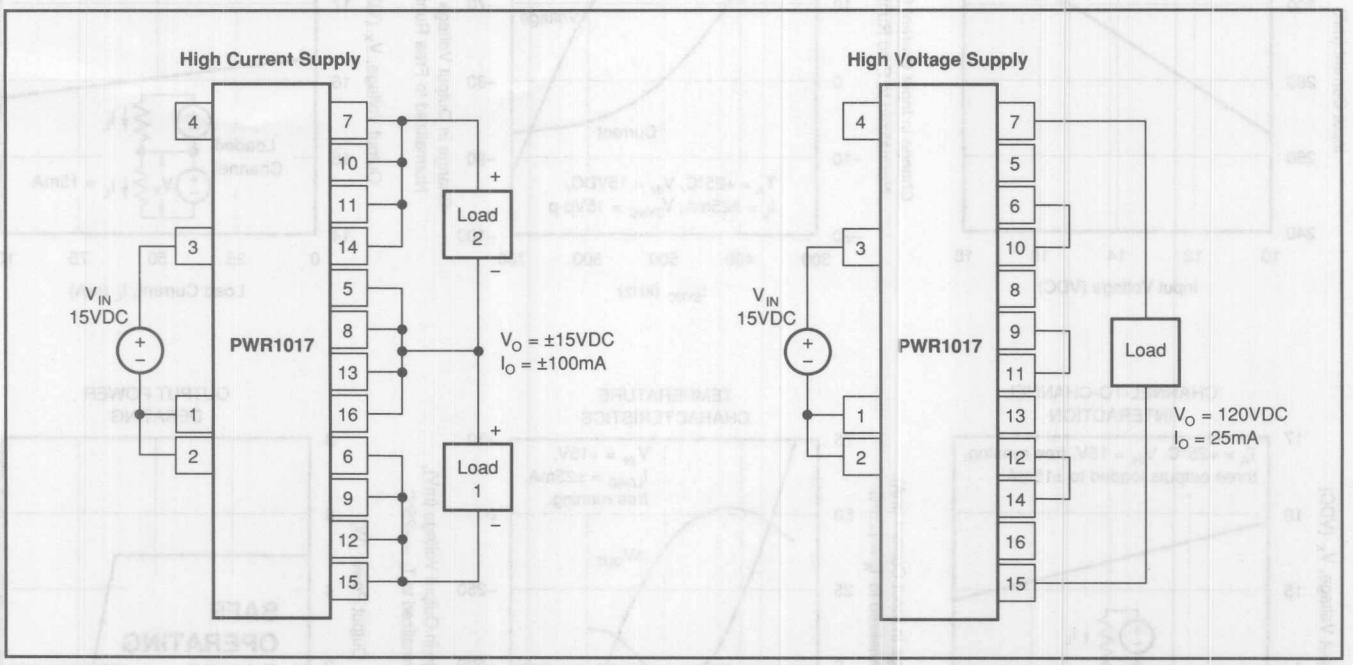
APPLICATION NOTES

CONTROL CIRCUITRY



NOTE: Care should be taken when the synchronization input pin is not used, in order to avoid the possibility of noise pickup and false PLL locking. This could destroy the unit and/or any other units that are coupled to its synchronization output (pin 4). This protection may be accomplished by either tying the synchronization pin to $-V_{IN}$, or clipping pin 1 off flush with the module surface. Tying pin 1 to $-V_{IN}$ is preferred.

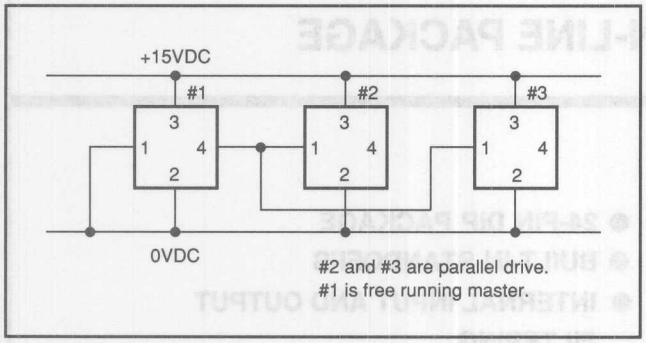
TYPICAL OUTPUT CONNECTIONS



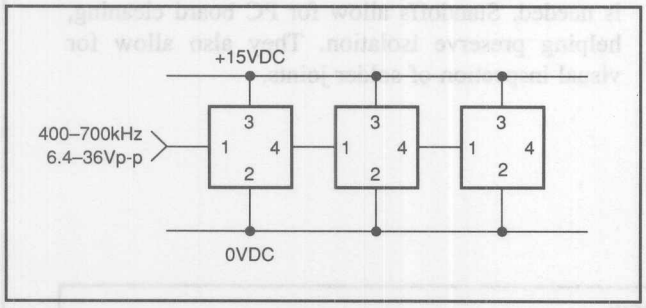
TYPICAL INPUT CONNECTIONS

Single Rail Input Supply

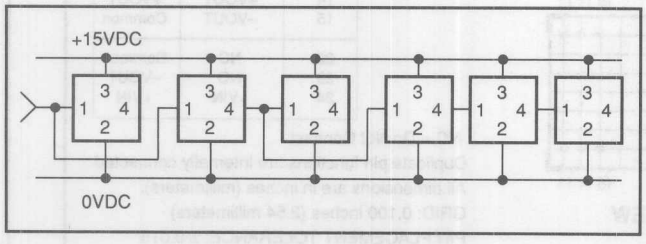
The PWR1017 can be connected in a number of configurations for single input voltages. Each unit may become either a master or a slave. The most common configuration is with a single master and multiple slave units.



The PWR1017 may also be connected in series where the first unit can either be a master or a slave driven by the system clock.

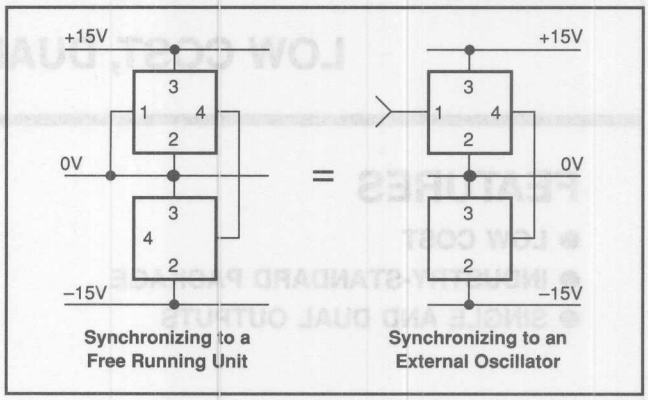


Any combination of serial or parallel may be used.

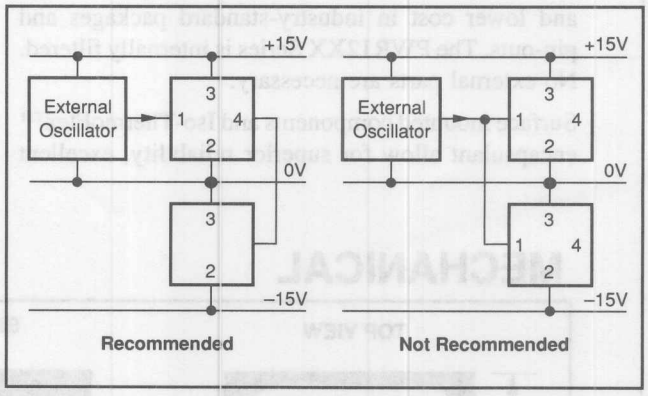


Split Rail Input Supply

PWR1017s may be driven by a differential supply and still be synchronized together. Care should be taken not to exceed the 50V maximum deviation from any $-V_{IN}$.



The master pin is a buffered output designed to drive other slave inputs. In split rail applications, it is recommended that the external oscillator drive only one unit, and that all others be driven from the master outputs of other PWR1017s.



BURR-BROWN®

PWR12XX SERIES

3 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

LOW COST, DUAL-IN-LINE PACKAGE

FEATURES

- LOW COST
- INDUSTRY-STANDARD PACKAGE
- SINGLE AND DUAL OUTPUTS
- 24-PIN DIP PACKAGE
- BUILT-IN STANDOFFS
- INTERNAL INPUT AND OUTPUT FILTERING

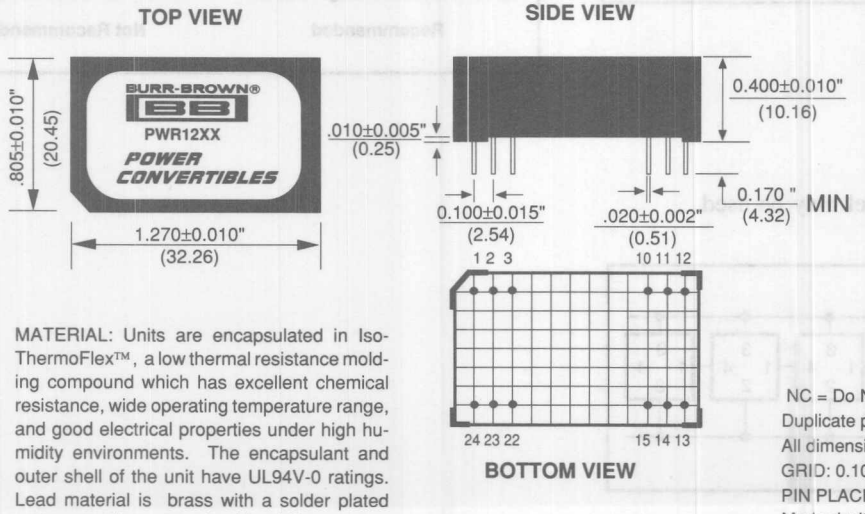
DESCRIPTION

The PWR12XX Series offers a broad line of low-cost, high-performance, unregulated, single and dual output DC/DC converters in a 24-pin DIP package. These miniature converters offer better performance and lower cost in industry-standard packages and pin-outs. The PWR12XX Series is internally filtered. No external parts are necessary.

Surface mounted components and Iso-ThermoFlex™ encapsulant allow for superior reliability, excellent thermal dissipation, and an extended temperature range of –25°C to +85°C at no extra cost.

The PWR12XX Series is ideal for use on high-density PC boards where isolated, unregulated, power is needed. Standoffs allow for PC board cleaning, helping preserve isolation. They also allow for visual inspection of solder joints.

MECHANICAL



PIN #	SINGLES	DUALS
1	+VIN	+VIN
2	NC	–VOUT
3	NC	Common
10	–VOUT	Common
11	+VOUT	+VOUT
12	–VIN	–VIN
13	–VIN	–VIN
14	+VOUT	+VOUT
15	–VOUT	Common
22	NC	Common
23	NC	–VOUT
24	+VIN	+VIN

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

NC = Do Not Connect
Duplicate pin functions are internally connected.
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

PDS-883B

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise noted.

MODEL	NOMINAL INPUT VOLTAGE	RATED OUTPUT VOLTAGE	RATED OUTPUT CURRENT	INPUT CURRENT		REFLECTED RIPPLE CURRENT
				NO LOAD	RATED LOAD	
UNITS	VDC	VDC	mA	mA	mA	mAp-p
PWR1200	5	5	600	30	800	45
PWR1201	5	12	250	30	800	45
PWR1202	5	15	200	30	800	45
PWR1203	5	±5	±300	30	800	45
PWR1204	5	±12	±125	30	800	45
PWR1205	5	±15	±100	30	800	45
PWR1206	12	5	600	30	330	25
PWR1207	12	12	250	30	330	25
PWR1208	12	15	200	30	330	25
PWR1209	12	±5	±300	30	330	25
PWR1210	12	±12	±125	30	330	25
PWR1211	12	±15	±100	30	330	25
PWR1212	15	5	600	30	265	20
PWR1213	15	12	250	30	265	20
PWR1214	15	15	200	30	265	20
PWR1215	15	±5	±300	30	265	20
PWR1216	15	±12	±125	30	265	20
PWR1217	15	±15	±100	30	265	20
PWR1218	24	5	600	30	165	20
PWR1219	24	12	250	30	165	20
PWR1220	24	15	200	30	165	20
PWR1221	24	±5	±300	30	165	20
PWR1222	24	±12	±125	30	165	20
PWR1223	24	±15	±100	30	165	20
PWR1240	5	9	333	30	800	45
PWR1241	12	9	333	30	330	25
PWR1242	15	9	333	30	265	20
PWR1243	24	9	333	30	165	20

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, and rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.5	5	5.5	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
		21.6	24	26.4	VDC
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60 Hz, 10 Seconds	500			Vpk
Resistance			10		GΩ
Capacitance			90		pF
Leakage Current	V_{ISO} = 240VAC, 60HZ		10		µArms
OUTPUT					
Rated Power			3		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}		±3	±5	%
Temperature Coefficient			±0.02		%/%°C
Ripple and Noise					
(BW = DC to 20MHz)	No External Components		150		mVp-p
	10µF Across Each Output		10		mVrms
	10µF Across Each Output		30		mVp-p
Voltage	No Load, V_{OUT} = +5V			7	VDC
	No Load, V_{OUT} = ±12V			±15	VDC
	No Load, V_{OUT} = ±15V			±18	VDC
Line Regulation			1.2		%/%V_{IN}
Load	No Load To Rated Load		6		%
GENERAL					
Package Weight			12		g
Switching Frequency			150		kHz
MTTF per MIL-HDBK-217, Rev E*	Circiut Stress Method		700		kHr
Efficiency			75		%
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–40		+125	°C
Storage		–40		+125	°C

* For demonstrated MTTF results reference Burr-Brown Reliability Report PWR1205 (Literature Number PA647)

ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration:	Momentary
Internal Power Dissipation	1.3W
Lead Temperature (Soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

PWR 12XX /H

Device Family
PWR Indicates DC/DC converter
Model Number
Selected from Table of Electrical Characteristics
Screening Option

APPLICATION NOTES

UNBALANCED LOADS

Unbalanced loads may be used on dual output models with either side providing up to its rated current. Output voltages, by design, will track each other in an unbalanced state within ±10% of one another.

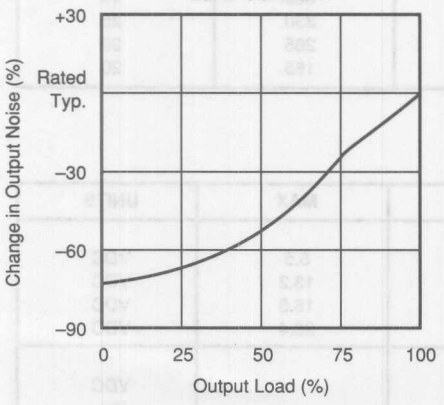
OUTPUT NOISE

Output noise can be reduced to 30mVp-p, typically, by adding a 10µF tantalum capacitor with an equivalent series resistance (ESR) of less than 150mΩ at 10kHz across each output.

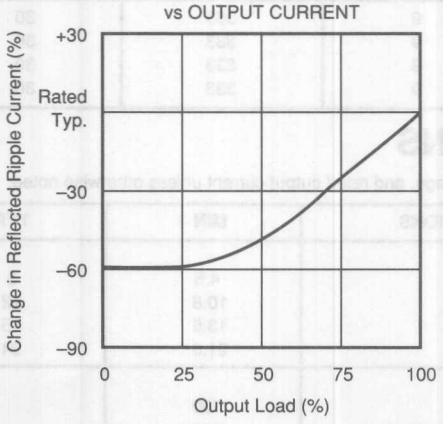
TYPICAL PERFORMANCE CURVES

T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

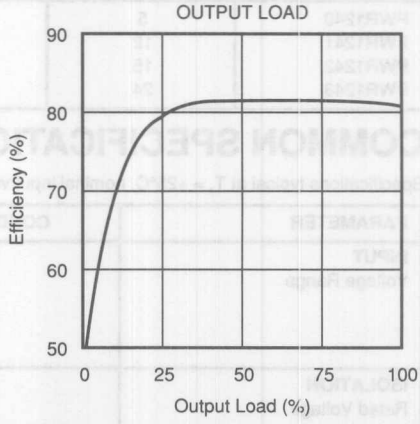
OUTPUT NOISE vs LOAD CURRENT



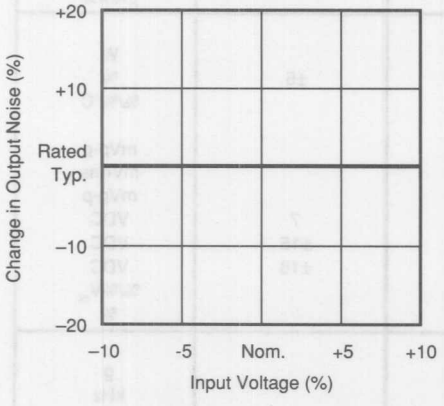
REFLECTED RIPPLE CURRENT vs OUTPUT CURRENT



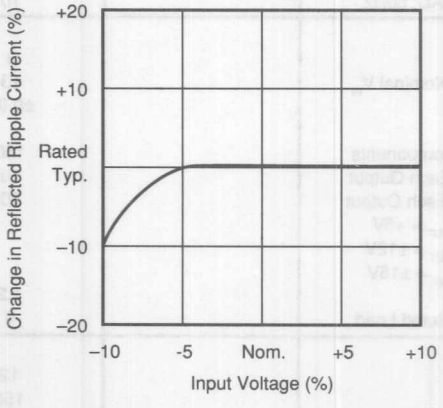
EFFICIENCY vs OUTPUT LOAD



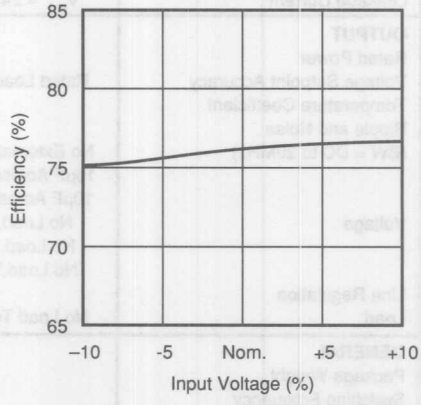
OUTPUT NOISE vs INPUT VOLTAGE



REFLECTED RIPPLE CURRENT vs INPUT VOLTAGE



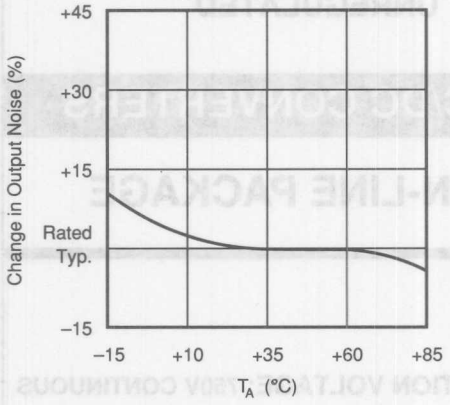
EFFICIENCY vs INPUT VOLTAGE



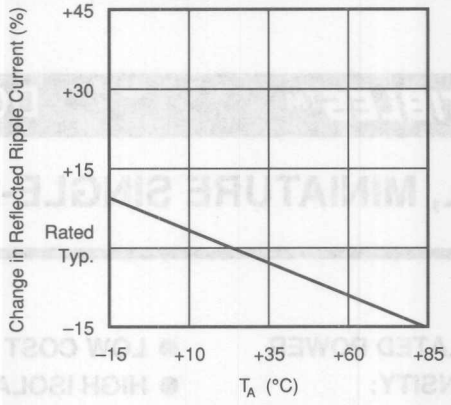
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

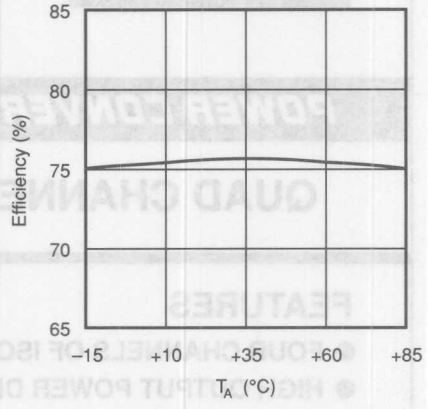
OUTPUT NOISE vs AMBIENT TEMPERATURE



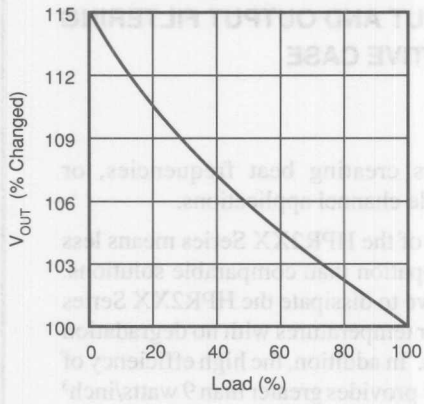
REFLECTED RIPPLE CURRENT vs AMBIENT TEMPERATURE



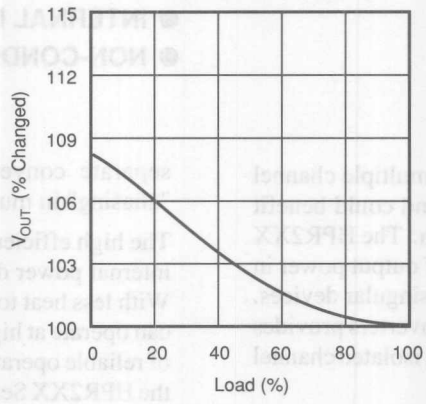
EFFICIENCY vs AMBIENT TEMPERATURE



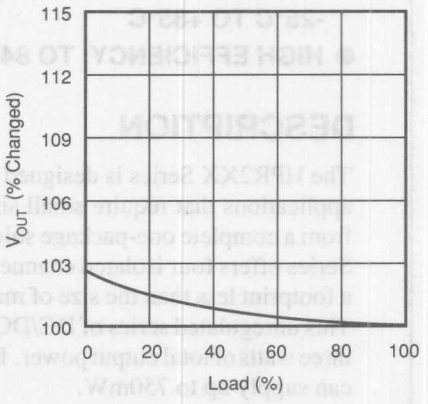
V_{OUT} vs LOAD ($5V_{OUT}$ MODELS)



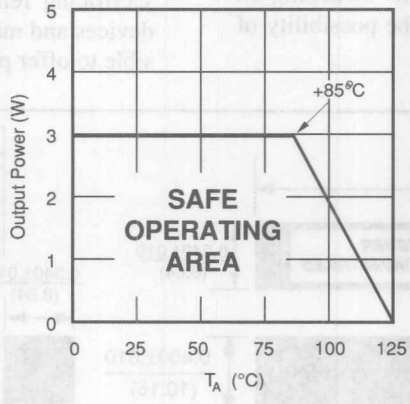
V_{OUT} vs LOAD ($\pm 12V_{OUT}$ MODELS)



V_{OUT} vs LOAD ($\pm 15V_{OUT}$ MODELS)



OUTPUT POWER DERATING



BURR-BROWN®

HPR2XX SERIES

3 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

QUAD CHANNEL, MINIATURE SINGLE-IN-LINE PACKAGE

FEATURES

- FOUR CHANNELS OF ISOLATED POWER
- HIGH OUTPUT POWER DENSITY: > 9. 4 WATTS/INCH³
- EXTENDED TEMPERATURE RANGE: -25°C TO +85°C
- HIGH EFFICIENCY: TO 84%
- LOW COST
- HIGH ISOLATION VOLTAGE: 750V CONTINUOUS INPUT-TO-OUTPUT AND CHANNEL-TO-CHANNEL
- SINGLE IN-LINE PACKAGE (SIP)
- INTERNAL INPUT AND OUTPUT FILTERING
- NON-CONDUCTIVE CASE

DESCRIPTION

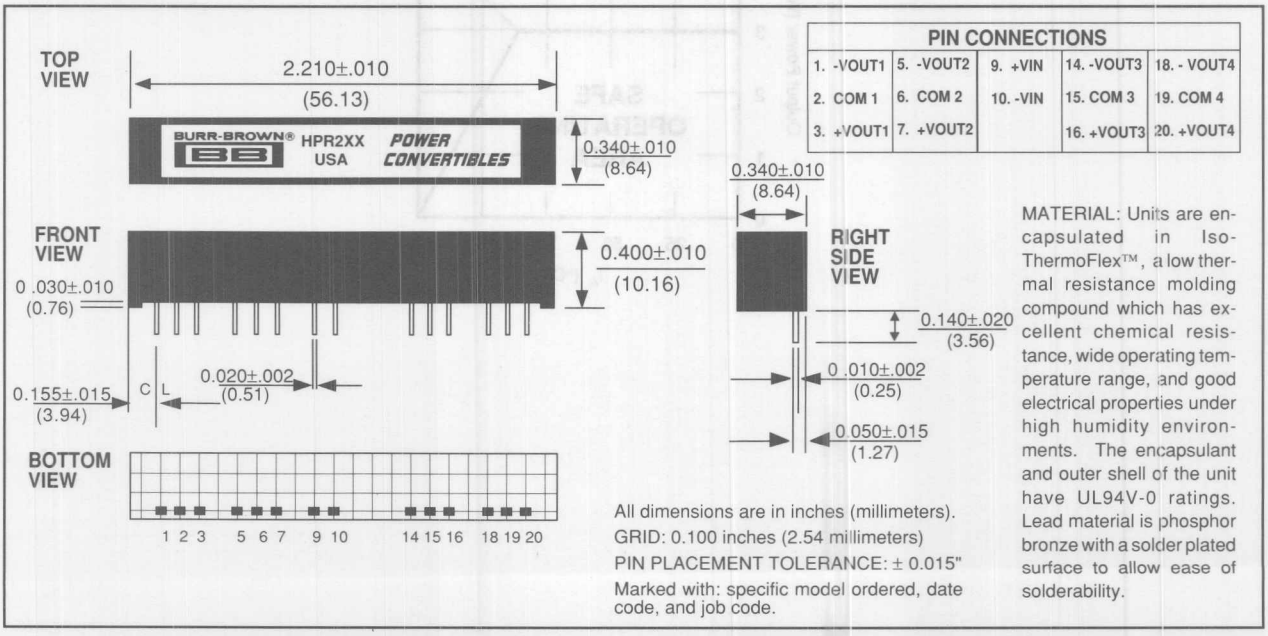
The HPR2XX Series is designed for multiple channel applications that require small size and could benefit from a complete one-package solution. The HPR2XX Series offers four isolated channels of output power in a footprint less than the size of many singular devices. This unregulated series of DC/DC converters provides three watts of total output power. Each isolated channel can supply up to 750mW.

The HPR2XX Series uses advanced circuit design and packaging technology to realize superior reliability and performance. With only one converter switching on the board, the HPR2XX eliminates the possibility of separate converters creating beat frequencies, or "aliasing" in multiple channel applications.

The high efficiency of the HPR2XX Series means less internal power dissipation than comparable solutions. With less heat to have to dissipate the HPR2XX Series can operate at higher temperatures with no degradation of reliable operation. In addition, the high efficiency of the HPR2XX Series provides greater than 9 watts/inch³ output power density.

The HPR2XX Series offers the user low cost without sacrificing reliability. The use of surface mounted devices and manufacturing technologies make it possible to offer premium performance and low cost.

MECHANICAL



PIN CONNECTIONS				
1. -VOUT1	5. -VOUT2	9. +VIN	14. -VOUT3	18. - VOUT4
2. COM 1	6. COM 2	10. -VIN	15. COM 3	19. COM 4
3. +VOUT1	7. +VOUT2		16. +VOUT3	20. +VOUT4

All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, and job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is phosphor bronze with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT MIN LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)
HPR203	5	±5.2	±73	70	820	35	74
HPR204	5	±12	±30	75	750	35	80
HPR205	5	±15	±25	75	750	35	80
HPR210	12	±12	±30	30	305	15	82
HPR211	12	±15	±25	30	300	15	84
HPR216	15	±12	±30	20	240	15	83
HPR217	15	±15	±25	20	240	20	84
HPR223	24	±15	±25	20	155	20	81

Note: Other input to output voltage options may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.5	5	5.5	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
		21.6	24	26.4	VDC
Voltage Rise Time	See Application Note: "Capacitive Loading Effects on Start-Up of DC/DC Converters"				
ISOLATION					
Rated Voltage	Input to Output, Channel to Channel	750			VDC
Test Voltage	60 Hz, 10 seconds	750			Vrms
Resistance			10		GΩ
Capacitance			30		pF
Leakage Current	V_{ISO}= 240VAC, 60Hz		4		µArms
OUTPUT					
Total Rated Power			3		W
Rated Power Each Channel			750		mW
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Ripple & Noise	BW = DC to 10MHz		40		mVp-p
	BW =10Hz to 2MHz		7		mVrms
Voltage	I_L=1mA, V_{OUT} = 5V			8	VDC
	I_L=1mA, V_{OUT} = 12V			17	VDC
	I_L=1mA, V_{OUT} = 15V			20	VDC
Temperature Coefficent			.05		%/Deg C
REGULATION					
Line Regulation	High Line to Low Line		1		%/%V_{IN}
Load Regulation (5V out only)	Rated Load to 1mA Load		10		%
Load Regulation (All other Models)	Rated Load to 1mA Load		3		%
GENERAL					
Switching Frequency			300		kHz
Package Weight			7		g
Frequency Change	Rated Load to 1mA Load		5		%
	High Line to Low Line		20		%
MTTF per MIL-HDBK-217, Rev. E	Circuit Stress Method				
Ground Benign	T_A = +25°C		1800		kHr
Fixed Ground	T_A = +35°C		450		kHr
Naval Sheltered	T_A = +35°C		270		kHr
Airborne Uninhabited Fighter	T_A = +35°C		45		kHr
TEMPERATURE					
Specification		-25	+25	+85	°C
Operation		-40		+100	°C
Storage		-40		+110	°C

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....1.2W
Short Circuit Protection.....< 1 second
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

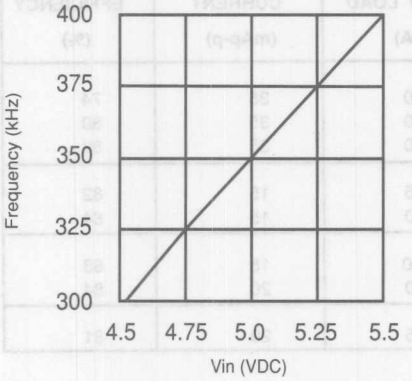
HPR 2XX /H

Device Family
HPR Indicates DC/DC Converter
Model Number
Selected From Table Above
Screening Option

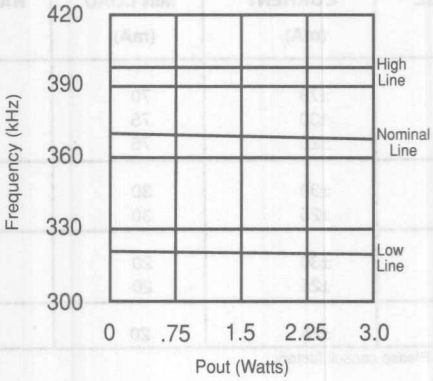
TYPICAL PERFORMANCE CURVES

T_A = +25 C, Rated Input Voltage, Rated Output Current unless otherwise noted.

FREQUENCY vs VIN

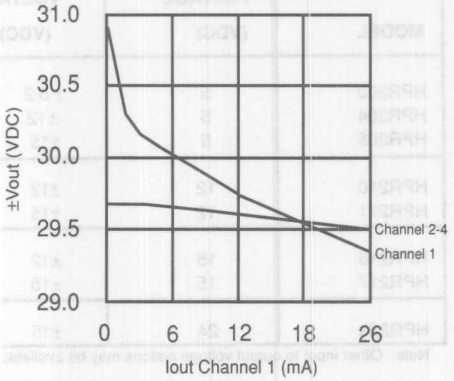


FREQUENCY vs Pout



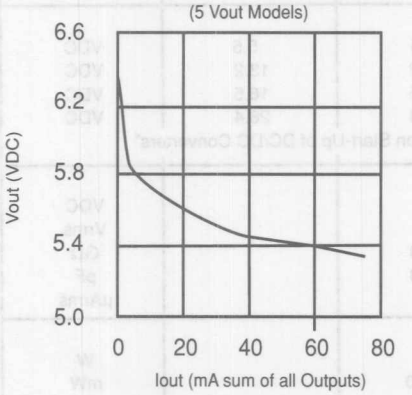
CROSS REGULATION HPR205

Channels 2-4: ±25mA Load



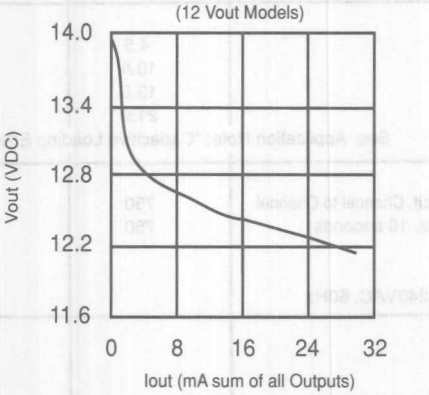
LOAD REGULATION

(5 Vout Models)



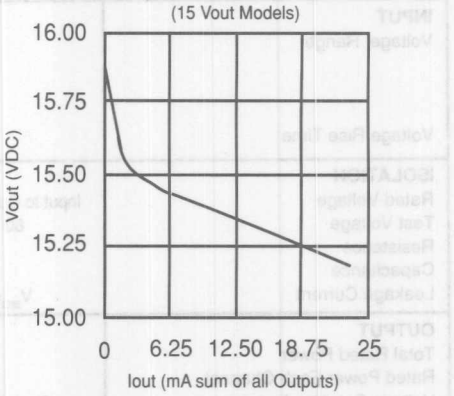
LOAD REGULATION

(12 Vout Models)

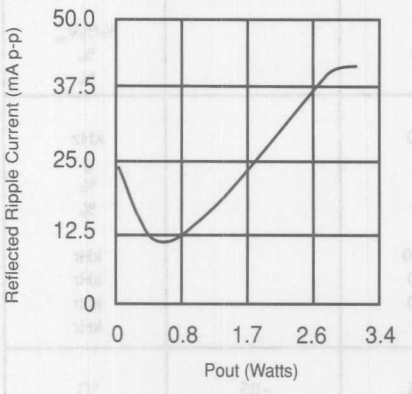


LOAD REGULATION

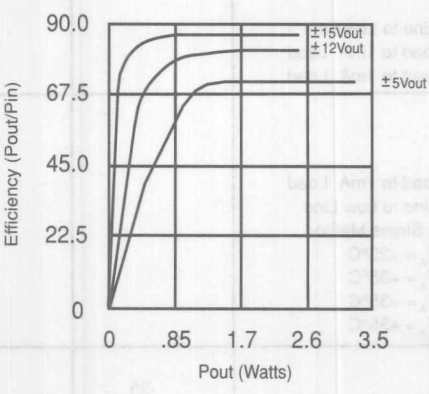
(15 Vout Models)



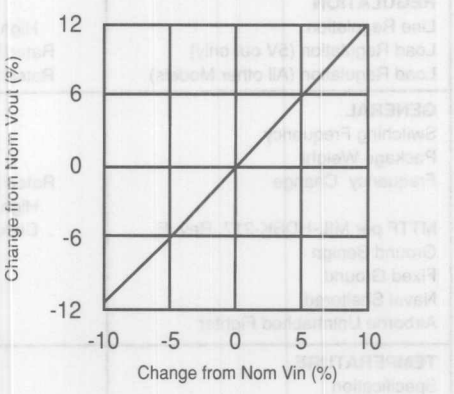
REFLECTED RIPPLE CURRENT vs Pout



EFFICIENCY vs OUTPUT POWER



LINE REGULATION



BURR-BROWN®

PWR40XX SERIES

4 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

LOW COST, INDUSTRY STANDARD PACKAGE

FEATURES

- LOW COST
- INDUSTRY-STANDARD PACKAGE
- SINGLE AND DUAL OUTPUTS
- INTERNAL INPUT AND OUTPUT FILTERING
- HIGH ISOLATION VOLTAGE OPTION AVAILABLE

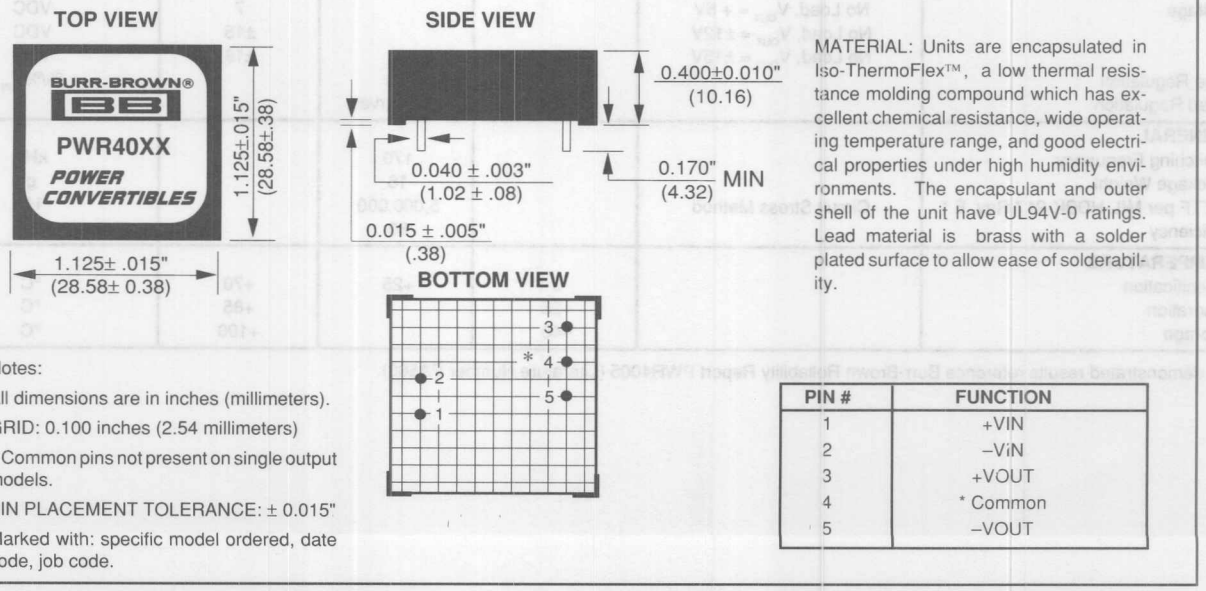
DESCRIPTION

The PWR40XX Series offers a low-cost alternative for some of the most popular DC/DC converters industry wide. Each model has a high-isolation version and an outstanding demonstrated MTTF of 5,000,000 hours at 25°C. The superior reliability and low cost make it an excellent choice for industry standard usages.

The series includes thirteen models (other input and output voltages are available upon request), all set in flexible encapsulation material, called Iso-ThermoFlex™, which has excellent thermal dissipation and low mechanical stress on internal components. The use of surface-mount devices and manufacturing processes, combined with the encapsulation process, provides the user a product that is environmentally rugged.

The PWR40XX has full isolation between input and output to give the designer maximum flexibility in grounding options and polarity configurations. The outputs are protected against momentary short circuits. An optional testing of the PWR40XX isolation barrier is performed per the methods set forth by UL544, VDE750, CSA 22.2 and IEC601-1.

MECHANICAL



MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Notes:

All dimensions are in inches (millimeters).

GRID: 0.100 inches (2.54 millimeters)

* Common pins not present on single output models.

PIN PLACEMENT TOLERANCE: ± 0.015"

Marked with: specific model ordered, date code, job code.

PIN #	FUNCTION
1	+VIN
2	–VIN
3	+VOUT
4	* Common
5	–VOUT

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage and rated output current unless otherwise specified.

MODEL	MINIMUM INPUT VOLTAGE (VDC)	NOMINAL INPUT VOLTAGE (VDC)	MAXIMUM INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT NO LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)
PWR4000	4.5	5.0	5.5	5.0	800	50	950	20
PWR4004	4.5	5.0	5.5	±12	±170	50	950	20
PWR4005	4.5	5.0	5.5	±15	±135	50	950	20
PWR4006	10.2	12.0	13.8	5.0	800	35	400	30
PWR4007	10.2	12.0	13.8	12.0	340	35	400	30
PWR4010	10.2	12.0	13.8	±12	±170	35	400	30
PWR4011	10.2	12.0	13.8	±15	±135	35	400	40
PWR4012	12.75	15.0	17.25	5.0	800	30	300	40
PWR4016	12.75	15.0	17.25	±12	±170	30	300	40
PWR4017	12.75	15.0	17.25	±15	±135	30	300	40
PWR4018	20.40	24.0	27.6	5.0	800	30	180	40
PWR4022	20.40	24.0	27.6	±12	±170	30	180	40
PWR4023	20.40	24.0	27.6	±15	±135	30	180	40

Other input and output voltage options may be available. Please contact factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage and rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
ISOLATION (Standard)					
Rated Voltage		500			VDC
Test Voltage	60Hz, 10 seconds	500			Vpk
Resistance			10		GΩ
Capacitance			50		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		5		µArms
ISOLATION (–HV Option)					
Rated Voltage		1000			VDC
Test Voltage	60Hz, 60 seconds	3000			Vpk
Resistance			10		GΩ
Capacitance			50		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		5	15	µArms
OUTPUT					
Rated Power			4.0		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}		±3	±5	%
Temperature Coefficient			±0.02		%/°C
Ripple & Noise	BW = DC to 10MHz		140		mVp-p
	BW = 10Hz to 20MHz		10		mVrms
Voltage	No Load, V_{OUT} = + 5V			7	VDC
	No Load, V_{OUT} = ±12V			±15	VDC
	No Load, V_{OUT} = ±15V			±18	VDC
Line Regulation			1.0		%/%V_{IN}
Load Regulation			See Curves		
GENERAL					
Switching Frequency			170		kHz
Package Weight			16		g
MTTF per MIL-HDBK-217 Rev. E *	Circuit Stress Method		5,000,000		Hr
Efficiency			80		%
TEMPERATURE					
Specification		0	+25	+70	°C
Operation		–25		+85	°C
Storage		–40		+100	°C

*For demonstrated results reference Burr-Brown Reliability Report PWR4005 (Literature Number PA560).

ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration	
Output to Common	1 second
Output to Output	1 second
Internal Power Dissipation	850mW
Lead Temperature (soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

PWR 40XX –HV /H

Device Family
PWR Indicates DC/DC Converter

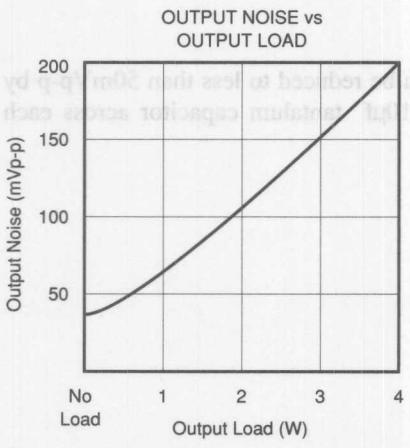
Model Number
Selected From Table of Electrical Characteristics

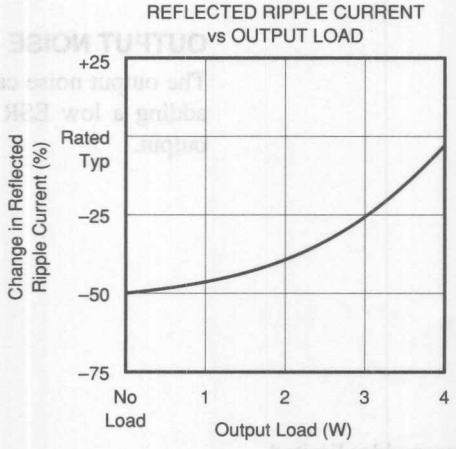
High Voltage Option
No Designator Indicates Standard Model

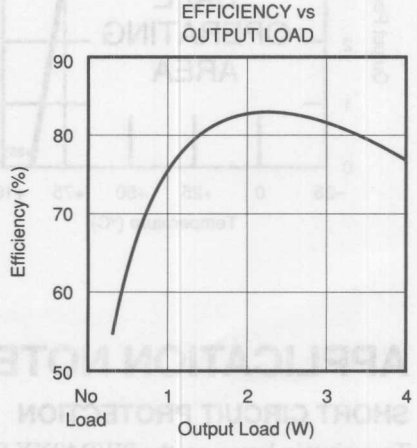
Optional Screening

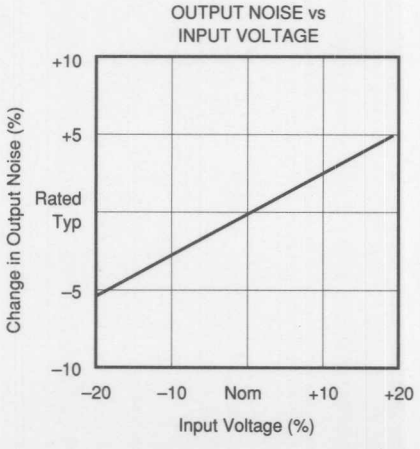
TYPICAL PERFORMANCE CURVES

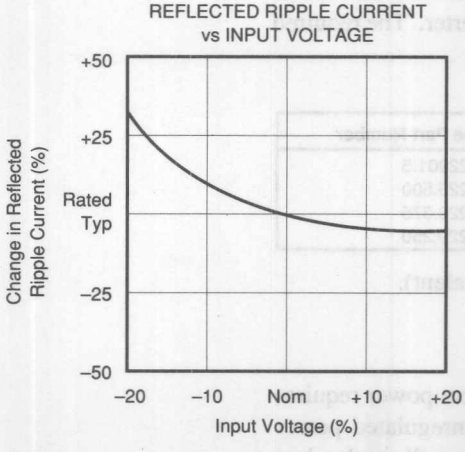
T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

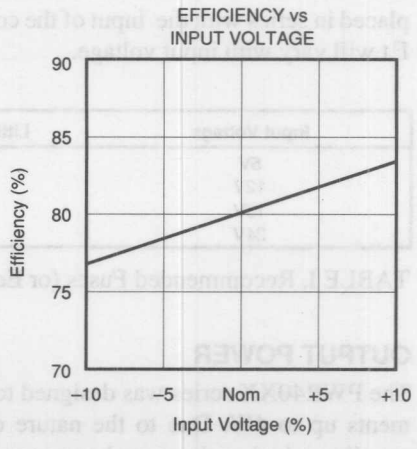






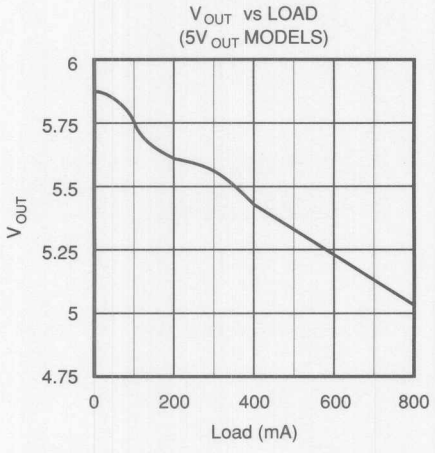


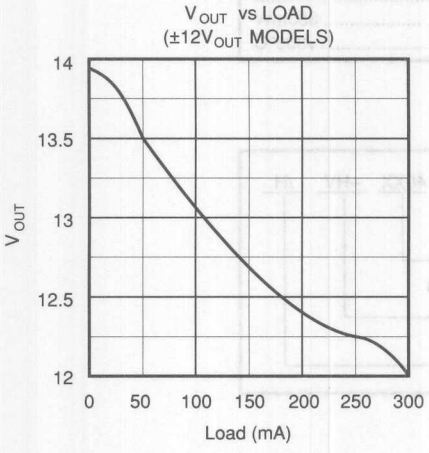


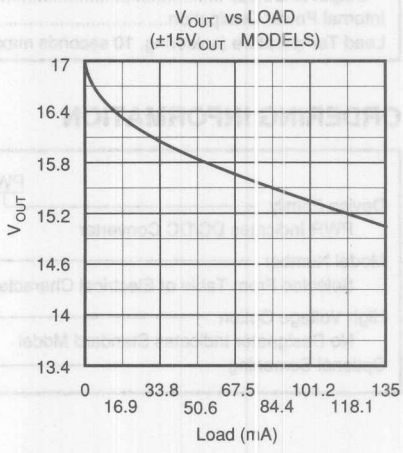


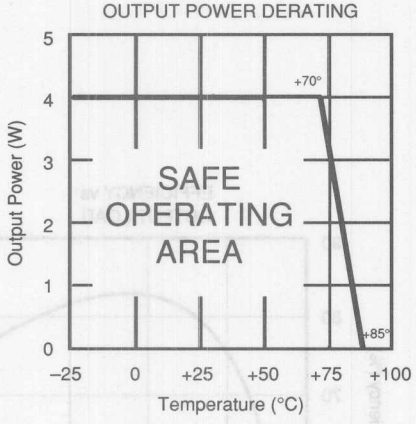
TYPICAL PERFORMANCE CURVES

T_A = +25°C, rated input voltage, rated output current unless otherwise noted.









UNBALANCED LOADS

Unbalanced loads may be used on dual output models with each side sourcing up to 200mA as long as the total power out is not more than 4W. With an unbalanced load, the output voltages will track within 5% of each other.

OUTPUT NOISE

The output noise can be reduced to less than 50mVp-p by adding a low ESR 10µf tantalum capacitor across each output.

APPLICATION NOTES

SHORT CIRCUIT PROTECTION

To maintain low cost, the PWR40XX Series provides limited short-circuit protection. To protect against continuous short circuits, a fuse is required. It is recommended that the fuse be placed in series with the input of the converter. The required I^2t will vary with input voltage.

Input Voltage	Littlefuse Part Number
5V	22901.5
12V	229.500
15V	229.375
24V	229.250

TABLE I. Recommended Fuses (or Equivalent).

OUTPUT POWER

The PWR40XX series was designed to meet power requirements up to 4W. Due to the nature of unregulated power supplies, a higher-than-rated output voltage will result when less-than-rated power is used (see Typical Performance Curves). This series has been designed to run from no load to 4W without derating up to +70°C.

BURR-BROWN®

PWR5XX SERIES
4 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

QUAD CHANNEL

FEATURES

- QUAD CHANNEL
- BARRIER LEAKAGE CURRENT 100% TESTED AT 240VAC
- SINGLE OR DUAL UNREGULATED OUTPUTS
- WIDE OPERATING TEMPERATURE RANGE: -40° TO +100°C
- INPUT AND OUTPUT FILTERING
- SIX-SIDED SHIELDING

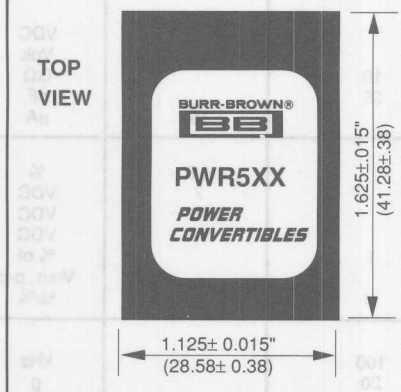
DESCRIPTION

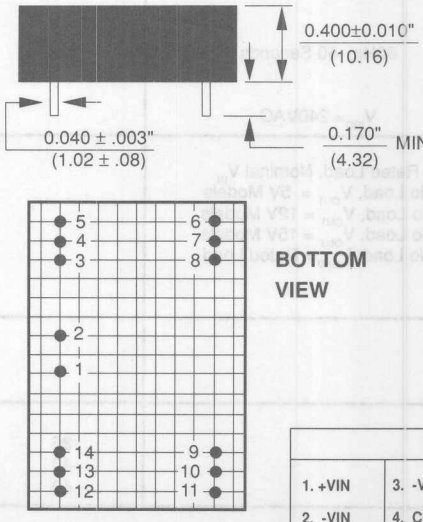
The PWR5XX Series offers a large selection of unregulated 4W DC/DC converters for use in such diverse applications as process control, telecommunications, portable equipment, medical systems, airborne and shipboard electronic circuits, and automatic test equipment.

Thirty-six models allow the user to select input voltages of 5VDC to 48 VDC and output voltages of 5, 12, 15, ±5, ±12, or ±15V.

Surface-mounted devices and manufacturing processes used in the PWR5XX Series provides the user a device that is environmentally rugged. Surface-mount technologies also gives the PWR5XX Series superior isolation voltage.

MECHANICAL





MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Notes:
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
Common pins not present on single output models.
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

PIN CONNECTIONS

1. +VIN	3. -VOUT1	6. -VOUT2	9. -VOUT3	12. - VOUT4
2. -VIN	4. COM1	7. COM2	10. COM 3	13. COM 4
	5. +VOUT1	8. +VOUT2	11. +VOUT3	14. +VOUT4

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	MAXIMUM INPUT CURRENT (mA)
PWR500	5	5	200	1300
PWR501	5	12	84	1290
PWR502	5	15	67	1230
PWR503	5	±5	±100	1300
PWR504	5	±12	±42	1290
PWR505	5	±15	±34	1230
PWR506	12	5	200	490
PWR507	12	12	84	444
PWR508	12	15	67	444
PWR509	12	±5	±100	490
PWR510	12	±12	±42	444
PWR511	12	±15	±34	444
PWR512	15	5	200	390
PWR513	15	12	84	355
PWR514	15	15	67	355
PWR515	15	±5	±100	390
PWR516	15	±12	±42	355
PWR517	15	±15	±34	355
PWR518	24	5	200	245
PWR519	24	12	84	222
PWR520	24	15	67	222
PWR521	24	±5	±100	245
PWR522	24	±12	±42	222
PWR523	24	±15	±34	222
PWR524	28	5	200	210
PWR525	28	12	84	190
PWR526	28	15	67	190
PWR527	28	±5	±100	222
PWR528	28	±12	±42	190
PWR529	28	±15	±34	190
PWR530	48	5	200	123
PWR531	48	12	84	111
PWR532	48	15	67	111
PWR533	48	±5	±100	123
PWR534	48	±12	±42	111
PWR535	48	±15	±34	111

NOTE: Other input to output voltages may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range				±20%	Nominal
Input Ripple Current	I_{LOAD} = Rated Load		70		mA, p-p
ISOLATION					
Rated Voltage		750			VDC
Test Voltage	60Hz, 60 Seconds	750			Vpk
Resistance			10		GΩ
Capacitance			55		pF
Leakage Current	V_{ISO}= 240VAC			15	µA
OUTPUT					
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Voltage	No Load, V_{OUT} = 5V Models			7	VDC
	No Load, V_{OUT} = 12V Models			15	VDC
	No Load, V_{OUT} = 15V Models			18	VDC
Ripple Voltage	No Load, I_{LOAD} = Rated Load		1		% of VOUT, p-p
Line Regulation			1		%/%
GENERAL					
Switching Frequency			100		kHz
Package Weight			20		g
TEMPERATURE					
Specification		-25	+25	+85	°C
Operation		-40		+100	°C
Storage		-40		+110	°C

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....2.5W
Short Circuit Protection.....<1 second
Lead Temperature (soldering, 10 seconds max).....+300°C

BURR-BROWN®

HPR7XX SERIES

5 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

LOW COST, SINGLE-IN-LINE PACKAGE

FEATURES

- LOW COST
- SIP PACKAGE
- HIGH POWER DENSITY: > 16 WATTS/INCH³
- EFFICIENCY >80%
- SINGLE AND DUAL OUTPUTS
- INTERNAL INPUT AND OUTPUT FILTERING
- SIX-SIDED SHIELDING

DESCRIPTION

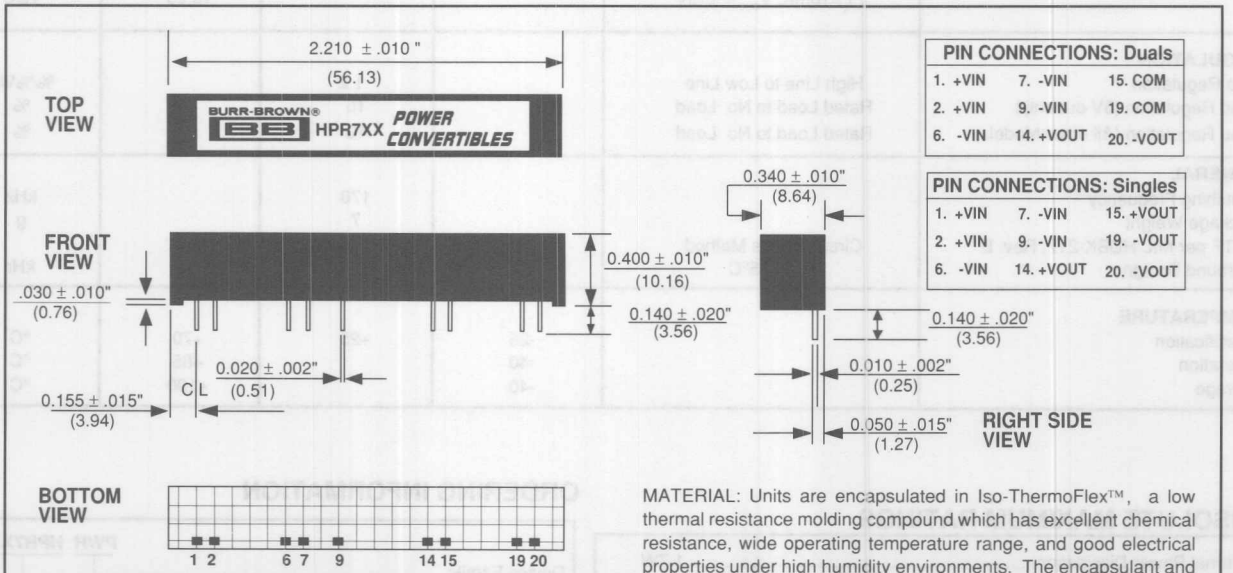
The HPR7XX Series Power Convertibles provide high power densities where space is critical. The small SIP package measures only 2.2" x .3" x .4" (56 x 9 x 10 mm). Designed for high density boards, the package is non-conductive, which presents advantages over painted metal enclosures.

The series includes many different voltage models (other input and output voltages are available upon request), all set in a low thermal resistance molding compound, called Iso-ThermoFlex™, which provides excellent heat dissipation of internal components. The use of surface mount devices and manufacturing processes, combined with the encapsulation process, assure the user that the product is more environmentally rugged than any other DC/DC converter of its type.

Operation down to no load will not impact the reliability of the series, although this product has a 10 mA minimum load for specification purposes. It is recommended that all pins be used for current carrying capacity even though duplicate pin-outs are internally connected.

The HPR7XX has 500VDC isolation barrier between input and output, offering the designer maximum flexibility in grounding options and polarity configurations. The outstanding MTTF, superior reliability, and low cost make it an excellent choice for any high power-density applications.

MECHANICAL



PIN CONNECTIONS: Duals		
1. +VIN	7. -VIN	15. COM
2. +VIN	9. -VIN	19. COM
6. -VIN	14. +VOUT	20. -VOUT

PIN CONNECTIONS: Singles		
1. +VIN	7. -VIN	15. +VOUT
2. +VIN	9. -VIN	19. -VOUT
6. -VIN	14. +VOUT	20. -VOUT

All dimensions are in inches (millimeters)
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ±0.015"

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is phosphor bronze with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL CHARACTERISTICS

Specifications typical at T_A = +25°C, nominal input voltage, rated output

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT MIN LOAD (mA)	INPUT CURRENT RATED LOAD (mA)	REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)
HPR700	5	5	1000	70	1250	15	80
HPR703	5	±5	±500	70	1250	15	80
HPR704	5	±12	±208	70	1190	15	84
HPR705	5	±15	±167	70	1190	15	84
HPR706	12	5	1000	25	490	15	80
HPR710	12	±12	±208	25	490	15	85
HPR711	12	±15	±167	25	490	15	85
HPR712	15	5	1000	20	407	15	82
HPR717	15	±15	±167	20	392	15	85

Other input to output voltage options may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.75	5	5.25	VDC
		11.4	12	12.6	VDC
		14.2	15	15.8	VDC
Voltage Rise Time	See Application Notes: "Capacitive Loading Effects on Start-Up of DC/DC Converters"				
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60 Hz, 10 seconds	500			Vpk
Resistance			1		GΩ
Capacitance			55		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		5		µArms
OUTPUT					
Rated Power			5		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}		±3		%
Temperature Coefficent			±0.05		%/Deg C
Ripple & Noise	BW = DC to 10MHz		50		mVp-p
	BW =10Hz to 2MHz		5		mVrms
Voltage	I_L=10mA, V_{OUT} = 5V			5.75	VDC
	I_L=10mA, V_{OUT} = ±12V			13.10	VDC
	I_L=10mA, V_{OUT} = ±15V			16.25	VDC
REGULATION					
Line Regulation	High Line to Low Line		1.2		%/%Vin
Load Regulation (5V out only)	Rated Load to No Load		15		%
Load Regulation (All other Models)	Rated Load to No Load		10		%
GENERAL					
Switching Frequency			170		kHz
Package Weight			7		g
MTTF per MIL-HDBK-217, Rev. E	Circuit Stress Method				
Ground Benign	T_A = +25°C		2000		kHr
TEMPERATURE					
Specification		-25	+25	+70	°C
Operation		-40		+85	°C
Storage		-40		+100	°C

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....1.7W
Short CIrcuit Protection.....Momentary
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

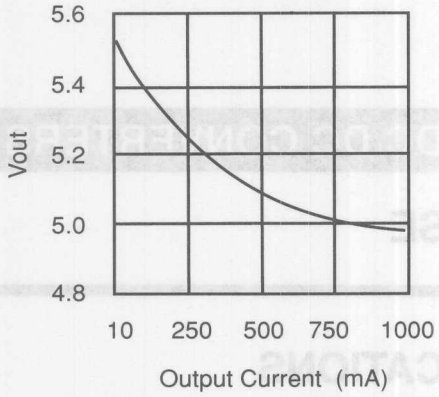
PWR HPR7XX /H

Device Family
PWR indicates DC/DC converter
Model Number
Screening Option

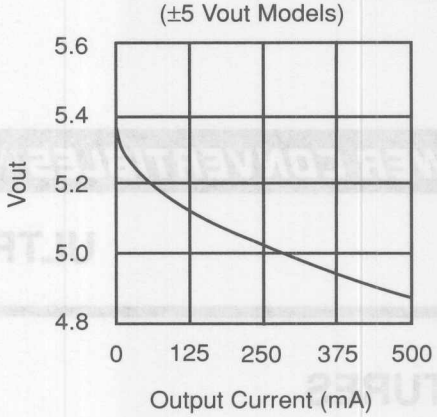
TYPICAL PERFORMANCE CURVES

T_A = +25 ° C, Rated Input Voltage, Rated Output Current unless otherwise noted.

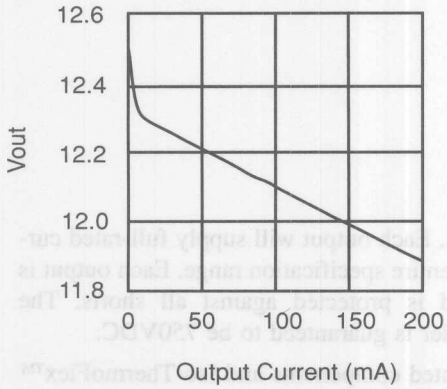
VOUT VS LOAD
(5 Vout Models)



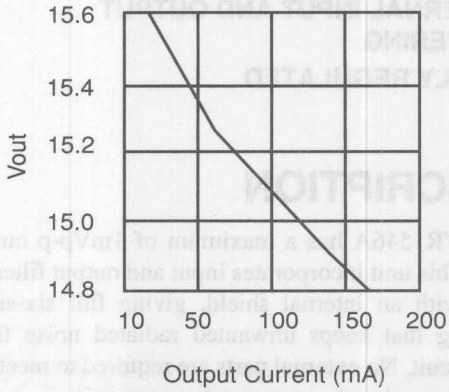
VOUT VS LOAD
(±5 Vout Models)



VOUT VS LOAD
(±12Vout Models)



VOUT VS LOAD
(±15Vout Models)



BURR-BROWN®

PWR1546A

5 WATTS REGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

ULTRA-LOW NOISE

FEATURES

- 1mVp-p MAXIMUM OUTPUT NOISE
- 5W RATED OUTPUT POWER
- SHORT-CIRCUIT PROTECTION
- SIX-SIDED SHIELDING
- INTERNAL INPUT AND OUTPUT FILTERING
- FULLY REGULATED

APPLICATIONS

- HIGH RESOLUTION DATA ACQUISITION
- PRECISION TEST EQUIPMENT
- HIGH GAIN AMPLIFIERS
- PRECISION INSTRUMENTATION

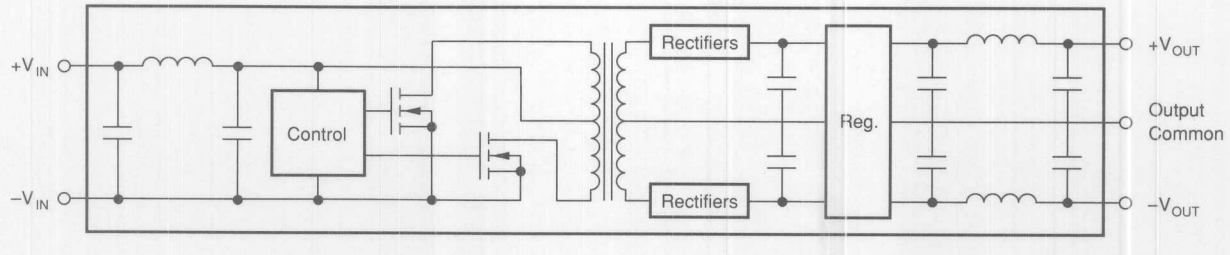
DESCRIPTION

The PWR1546A has a maximum of 1mVp-p output noise. This unit incorporates input and output filtering along with an internal shield, giving full six-sided shielding that keeps unwanted radiated noise from your circuit. No external parts are required to meet the 1mVp-p maximum guaranteed output noise.

The PWR1546A is a miniature DC/DC converter providing dual isolated ±15VDC outputs from a single +5VDC input. Each output will supply full-rated current over the entire specification range. Each output is regulated and is protected against all shorts. The isolation barrier is guaranteed to be 750VDC.

Surface-mounted components and Iso-ThermoFlex™ encapsulant allow superior reliability and excellent thermal dissipation. The calculated MTTF (per MIL-HDBK-217 Rev. E, Circuit-Stress Analysis Method) is in excess of 100 years at 25°C.

SIMPLIFIED CIRCUIT DIAGRAM



Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

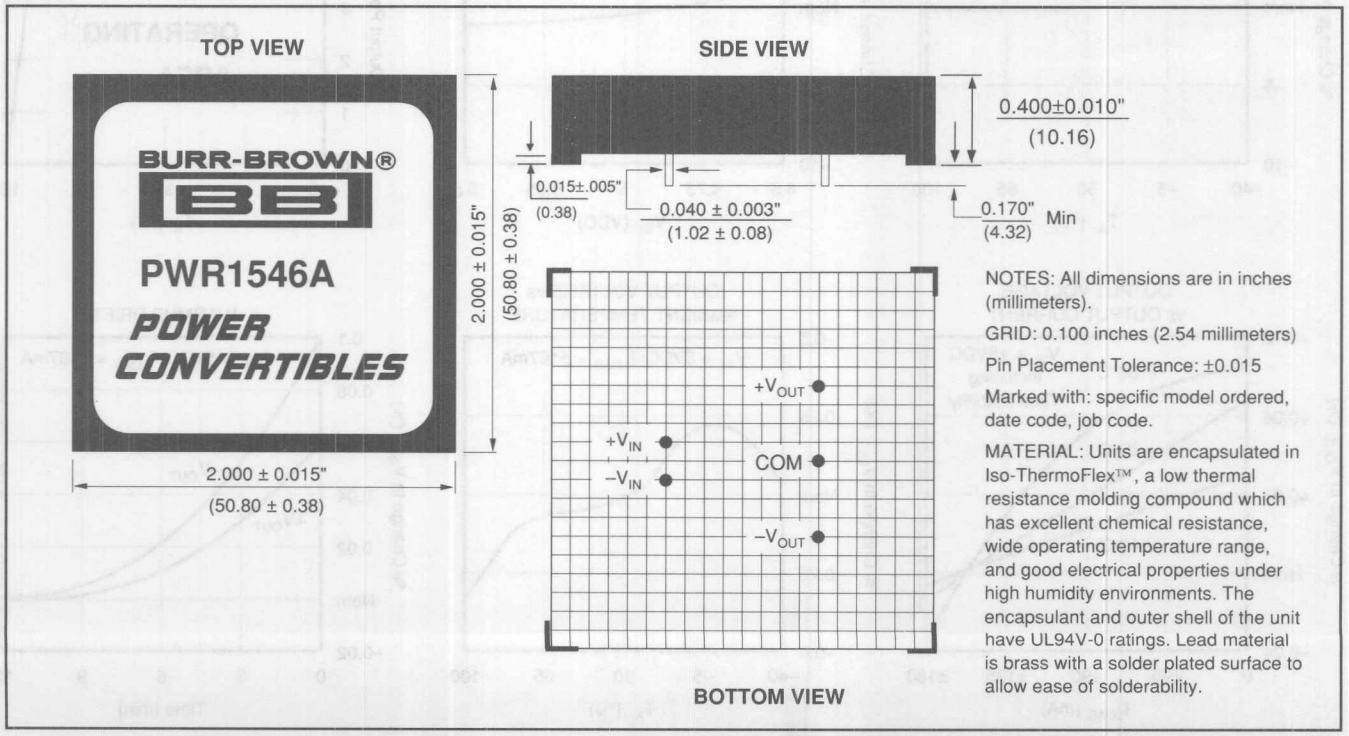
SPECIFICATIONS

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, rated input voltage, rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Rated Voltage			5.0		VDC
Voltage Range		4.5		5.5	VDC
Current	I_{LOAD} = 0		80		mA
	I_{LOAD} = Rated Output		1650		mA
Reflected Ripple Current	BW = DC to 10MHz		18		mAp-p
ISOLATION					
Rated Voltage		750			VDC
Test Voltage	60 Hz, 10 seconds	750			Vpk
Resistance			10		GΩ
Capacitance			110		pF
Leakage Current	V_{ISO} = 240VAC, 60HZ			15	µArms
OUTPUT					
Rated Voltage			±15		VDC
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±1	%
Voltage Balance				±0.5	%
Temperature Coefficient			±0.01		%/°C
Rated Current			±167		mA
Transient Recovery Time	To 0.1% of Final Value		10		ms
REGULATION					
Line	4.5VDC to 5.5VDC		±0.02		%
Load	0mA to ±167mA		0.02		%
OUTPUT NOISE					
Ripple and Noise	BW = DC to 10MHz		0.6	1.0	mVp-p
GENERAL					
Efficiency			60		%
Package Weight			50		g
Switching Frequency			50		kHz
MTTF per MIL-HDBK-217, Rev E.	Circuit Stress Method, T_A=+25°C		890		kHr
TEMPERATURE					
Specification		–25	+25	+85	°C
Operating		–40		+100	°C
Storage		–55		+125	°C

MECHANICAL



NOTES: All dimensions are in inches (millimeters).

GRID: 0.100 inches (2.54 millimeters)

Pin Placement Tolerance: ±0.015

Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

ORDERING INFORMATION

PWR 1546A /H

Device Family
PWR indicates DC/DC converter
Model Number
Screening Option

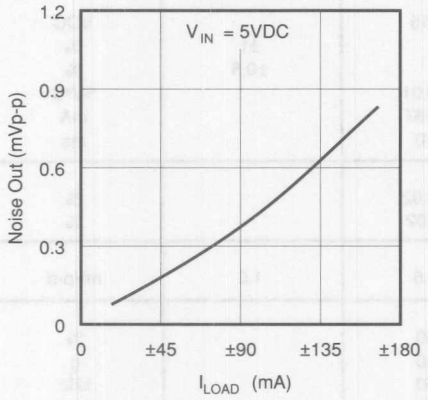
ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration	Continuous
Internal Power Dissipation	4W
Lead Temperature (soldering, 10 seconds max)	+300°C

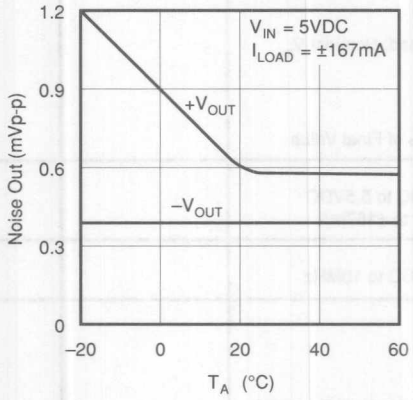
TYPICAL PERFORMANCE CURVES

T_A = +25°C, V_{IN} = 5VDC, I_{LOAD} = ±167mA unless otherwise noted.

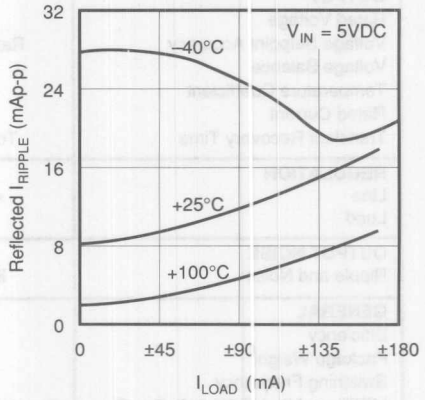
OUTPUT NOISE vs OUTPUT CURRENT



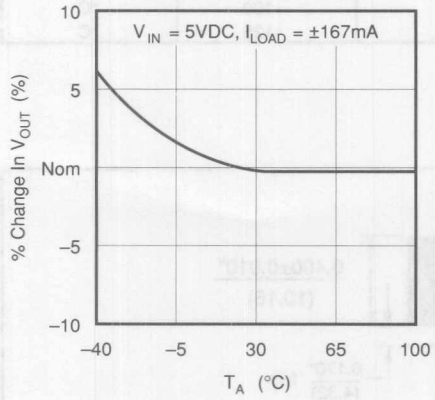
OUTPUT NOISE vs AMBIENT TEMPERATURE



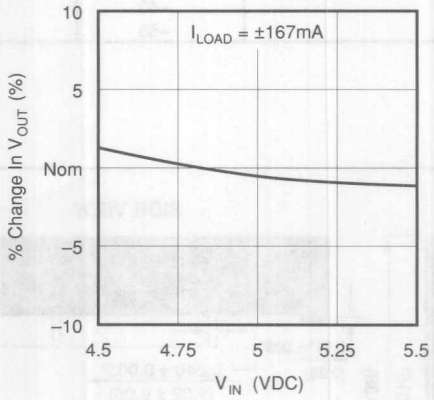
REFLECTED RIPPLE CURRENT vs OUTPUT CURRENT



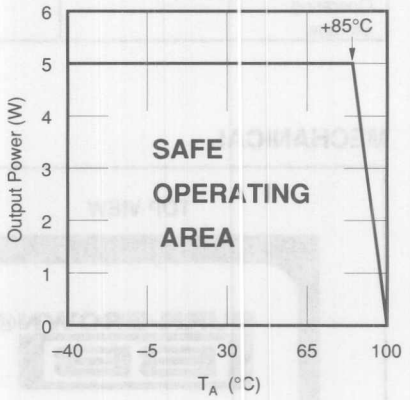
INPUT CURRENT vs AMBIENT TEMPERATURE



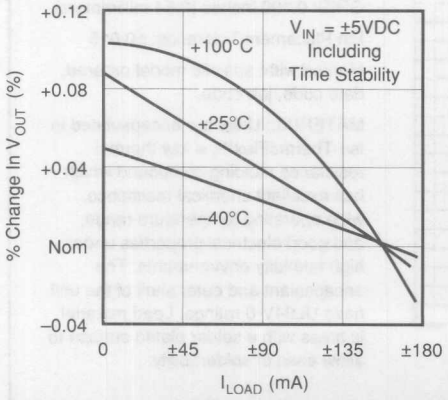
INPUT CURRENT vs INPUT VOLTAGE



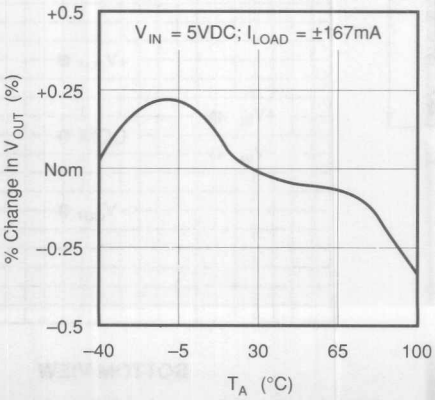
POWER DERATING



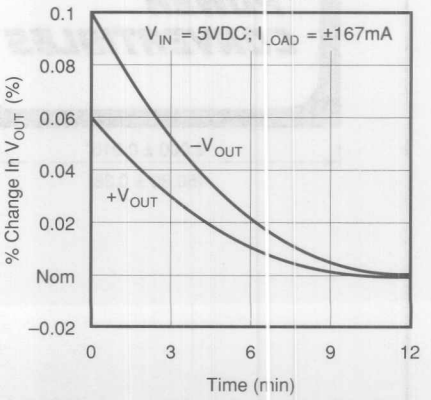
OUTPUT VOLTAGE vs OUTPUT CURRENT



OUTPUT VOLTAGE vs AMBIENT TEMPERATURE



WARMUP DRIFT



BURR-BROWN®

PWR70XX SERIES

5 WATTS
REGULATED

POWER CONVERTIBLES™ **DC/DC CONVERTERS**

INDUSTRY STANDARD PINOUT, LOW COST

FEATURES

- HIGH RELIABILITY
- SHORT-CIRCUIT PROTECTED
- FOLDBACK CURRENT LIMIT
- HIGH EFFICIENCY
- LINEAR OUTPUT REGULATION
- TRACKING OUTPUTS
- SIX-SIDED SHIELDING
- INTERNAL INPUT AND OUTPUT FILTERING
- NON-CONDUCTIVE CASE
- INDUSTRY STANDARD PINOUT
- 500VDC ISOLATION

DESCRIPTION

The PWR70XX Series uses advanced circuit design and packaging technology to realize superior reliability and performance. A 170kHz driven push-pull oscillator is used to ensure stable frequency and non-saturating operation of the input stage. This means there are no high peak voltages or currents like other design topologies, which can severely reduce unit reliability. Reliability is further enhanced by the use of MOSPOWER transistors. These rugged devices permit higher frequency operation with less complicated drive circuitry than is possible with bipolar power transistors. Reduced parts count adds to the reliability of the PWR70XX Series.

Continuous short-circuit protection and foldback current limiting make the PWR70XX Series rugged devices for use in demanding system applications. These features add to the overall reliability of the PWR70XX Series by reducing the possibility of inadvertently damaging the unit due to an output overload.

The high efficiency of the PWR70XX Series means low internal power dissipation. With less heat dissipated, the PWR70XX Series can operate at higher ambient temperature with no degradation of reliablility.

The PWR70XX Series offers the user low cost without sacrificing reliability. The use of surface mounted devices and manufacturing technologies makes it possible to offer premium performance and low cost.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	RATED OUTPUT CURRENT (mA)	INPUT CURRENT		REFLECTED RIPPLE CURRENT (mAp-p)	EFFICIENCY (%)
				NO LOAD (mA)	RATED LOAD (mA)		
PWR7000	5	5	1000	50	1580	30	63
PWR7004	5	±12	±210	50	1490	30	67
PWR7005	5	±15	±167	50	1450	30	69
PWR7006	12	5	1000	30	620	30	67
PWR7010	12	±12	±210	30	580	30	72
PWR7011	12	±15	±167	30	570	30	73
PWR7012	15	5	1000	30	500	30	67
PWR7016	15	±12	±210	30	480	30	70
PWR7017	15	±15	±167	30	460	30	73
PWR7018	24	5	1000	30	320	30	65
PWR7022	24	±12	±210	30	310	30	67
PWR7023	24	±15	±167	30	305	30	68
PWR7030	48	5	1000	20	165	30	63
PWR7033	48	± 5	±500	20	168	30	62

Note: Other input to output voltages may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		4.75	5	5.25	VDC
		10.8	12	13.2	VDC
		13.5	15	16.5	VDC
		21.6	24	26.5	VDC
		43.2	48	52.8	VDC
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60Hz, 10 Seconds	500			Vpk
Resistance			10		GΩ
Capacitance			80		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		10	18	µArms
OUTPUT					
Rated Power			5		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±1	%
Temperature Coefficient			±0.02		%/°C
Ripple and Noise	BW = DC to 10MHz		30		mVp-p
	BW = DC to 2MHz		5		mVrms
Tracking	$-V_{OUT}$ Tracks $+V_{OUT}$		±1		%
TRANSIENT RESPONSE					
5V Output Models (Within ±1%)	Rated Load to No Load		50		µs
	No Load to Rated Load		100		µs
All Other Models (Within ±0.1%)	Rated Load to No Load		30		µs
	No Load to Rated Load		100		µs
REGULATION					
Line Regulation	High Line to Low Line		±0.02		%
Load Regulation	Rated Load to No Load				
5V Output Models			±0.04		%
All Other Models			±0.02		%
GENERAL					
Switching Frequency			170		kHz
Package Weight			50		g
MTTF per MIL-HDBK-217, Rev. E*	Circuit Stress Method				
Ground Benign	T_A = +25°C		762,000		Hr
	T_A = +70°C		46,000		Hr
Fixed Ground	T_A = +35°C		230,000		Hr
Naval Sheltered	T_A = +35°C		127,000		Hr
Airborne Uninhabited Fighter	T_A = +35°C		29,000		Hr
TEMPERATURE					
Specification		0	+25	+70	°C
Operation		–25		+85	°C
Storage		–40		+110	°C

* For demonstrated MTTF results reference Burr-Brown Reliability Report PWR7005 (Literature Number PA649).

ABSOLUTE MAXIMUM RATINGS

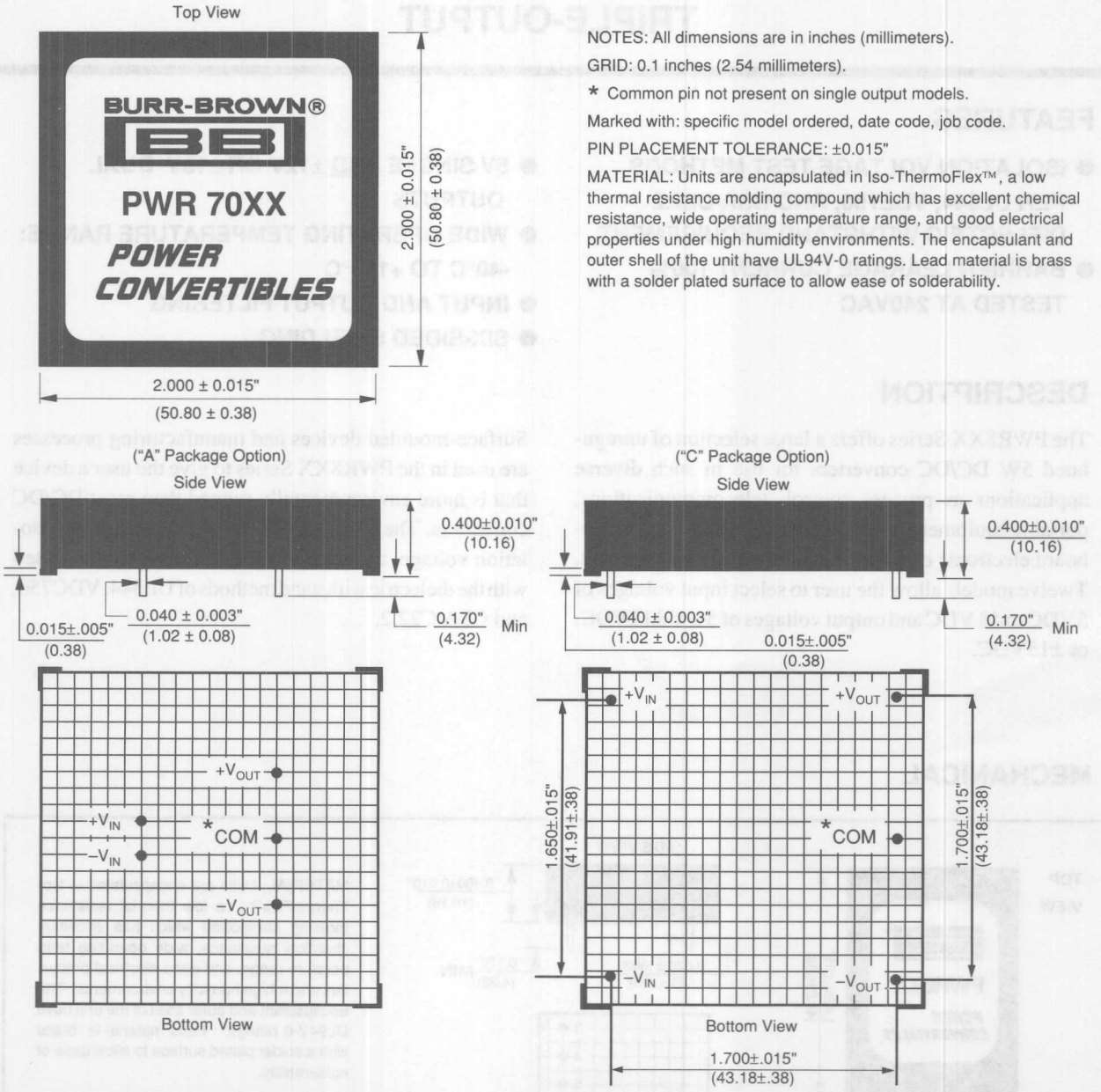
Output Short-Circuit Duration	Continuous
Internal Power Dissipation	3.5W
Lead Temperature (soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

PWR 70XX A /H

- Device Family — PWR Indicates DC/DC Converter
- Model Number — Selected from Table of Electrical Characteristics
- Package Option — A or C (see Mechanical section)
- Screening Option

MECHANICAL



NOTES: All dimensions are in inches (millimeters).

GRID: 0.1 inches (2.54 millimeters).

* Common pin not present on single output models.

Marked with: specific model ordered, date code, job code.

PIN PLACEMENT TOLERANCE: ±0.015"

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

BURR-BROWN®

PWR8XX SERIES

5 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

TRIPLE-OUTPUT

FEATURES

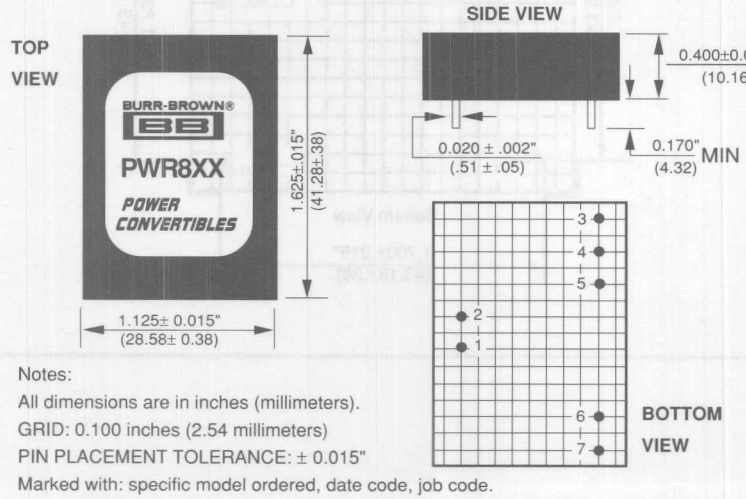
- ISOLATION VOLTAGE TEST METHODS PER UL544, VDE750, AND CSA C22.2 DIELECTRIC WITHSTAND REQUIREMENT
- BARRIER LEAKAGE CURRENT 100% TESTED AT 240VAC
- 5V SINGLE AND ±12V OR ±15V DUAL OUTPUTS
- WIDE OPERATING TEMPERATURE RANGE: -40°C TO +100°C
- INPUT AND OUTPUT FILTERING
- SIX-SIDED SHIELDING

DESCRIPTION

The PWR8XX Series offers a large selection of unregulated 5W DC/DC converters for use in such diverse applications as process control, telecommunications, portable equipment, medical systems, airborne and shipboard electronic circuits, and automatic test equipment. Twelve models allow the user to select input voltages of 5VDC to 48 VDC and output voltages of 5 and ±12VDC, or ±15VDC.

Surface-mounted devices and manufacturing processes are used in the PWR8XX Series to give the user a device that is more environmentally rugged than most DC/DC converters. The PWR8XX Series provides superior isolation voltage, and each PWR8XX Series unit is tested with the dielectric withstand methods of UL544, VDC750, and CSA C22.2.

MECHANICAL



Notes:
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

PIN CONNECTIONS		
1.+VIN	3. +VOUT2	6. +VOUT1
2. -VIN	4. COM	7. -VOUT1
	5. -VOUT2	

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

MODEL	NOMINAL INPUT VOLTAGE (VDC)	CHANNEL 1 RATED OUTPUT		CHANNEL 2 RATED OUTPUT		MAXIMUM INPUT CURRENT (mA)
		VOLTAGE (VDC)	CURRENT (mA)	VOLTAGE (mA)	CURRENT (mA)	
PWR800	5	5	250	±12	±156	1665
PWR801	5	5	250	±15	±125	1665
PWR802	12	5	250	±12	±156	695
PWR803	12	5	250	±15	±125	695
PWR804	15	5	250	±12	±156	555
PWR805	15	5	250	±15	±125	555
PWR806	24	5	250	±12	±156	345
PWR807	24	5	250	±15	±125	345
PWR808	28	5	250	±12	±156	295
PWR809	28	5	250	±15	±125	295
PWR810	48	5	250	±12	±156	170
PWR811	48	5	250	±15	±125	170

Note: Other input to output voltages may be available. Please consult factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range				±20%	
Input Ripple Current	I_{LOAD} = Rated Load		50		mA, p-p
ISOLATION					
Rated Voltage		1000			VDC
Test Voltage	60Hz, 60 seconds	3000			V_{PK}
Resistance			10		GΩ
Capacitance			80		pF
Leakage Current	V_{ISO}= 240VAC			15	µA
OUTPUT					
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			±5	%
Voltage	No Load, V_{OUT} = 5V Models			7	VDC
	No Load, V_{OUT} = 12V Models			15	VDC
	No Load, V_{OUT} = 15V Models			18	VDC
Ripple Voltage	Rated Load, Nominal V_{IN}		100		mV, p-p
Line Regulation			1		%/%
TEMPERATURE					
Specification		-25	+25	+85	°C
Operation		-40		+100	°C
Storage		-55		+125	°C
GENERAL					
Package Weight			20		g
Switching Frequency			50		kHz

ABSOLUTE MAXIMUM RATINGS

Internal Power Dissipation.....4W
Short Circuit Protection.....<1 Second
Lead Temperature (soldering, 10 seconds max).....+300°C

ORDERING INFORMATION

PWR 8XX /H

Device Family
PWR Indicates DC/DC Converter

Model Number
Selected from Table of Electrical Characteristics

Screening Option

BURR-BROWN®

PWR62XX SERIES

5.2 WATTS
REGULATED

POWER CONVERTIBLES™ **DC/DC CONVERTERS**

-5.2VDC OUTPUT, ECL POWER SUPPLY

FEATURES

- -5.2VDC OUTPUT
- LINEAR OUTPUT REGULATION
- INPUT AND OUTPUT FILTERING
- SIX-SIDED SHIELDING
- 1000mA OUTPUT CURRENT
- 5, 12, 15, 24, 28, and 48VDC INPUTS
- ISOLATED
- SHORT-CIRCUIT PROTECTION

APPLICATIONS

- ECL LOGIC SUPPLY
- HIGH SPEED ADC
- COMPUTERS

DESCRIPTION

The PWR62XX offers a selection of regulated 5.2W DC/DC converters for powering ECL systems. The -5.2VDC output and various input voltages are fully isolated, allowing the designer flexibility in grounding and polarity configurations.

This series is the only DC/DC converter available that provides -5.2VDC for ECL logic with no external trimming components. This reduces parts count, labor and costs in the end product. The PWR62XX Series has a low 25mVp-p typical output ripple and noise specification. No external parts are necessary to obtain this performance. The absence of extra external filtering components further reduces total costs.

Surface-mounted devices and manufacturing processes are used in the PWR62XX to give the user a device more environmentally rugged than most converters. Power Convertibles' flexible encapsulant, Iso-ThermoFlex™, allows for excellent thermal dissipation and superior reliability. All models incorporate input and output filtering along with six-sided shielding to keep unwanted noise from your sensitive circuitry. Low noise insures system integrity.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

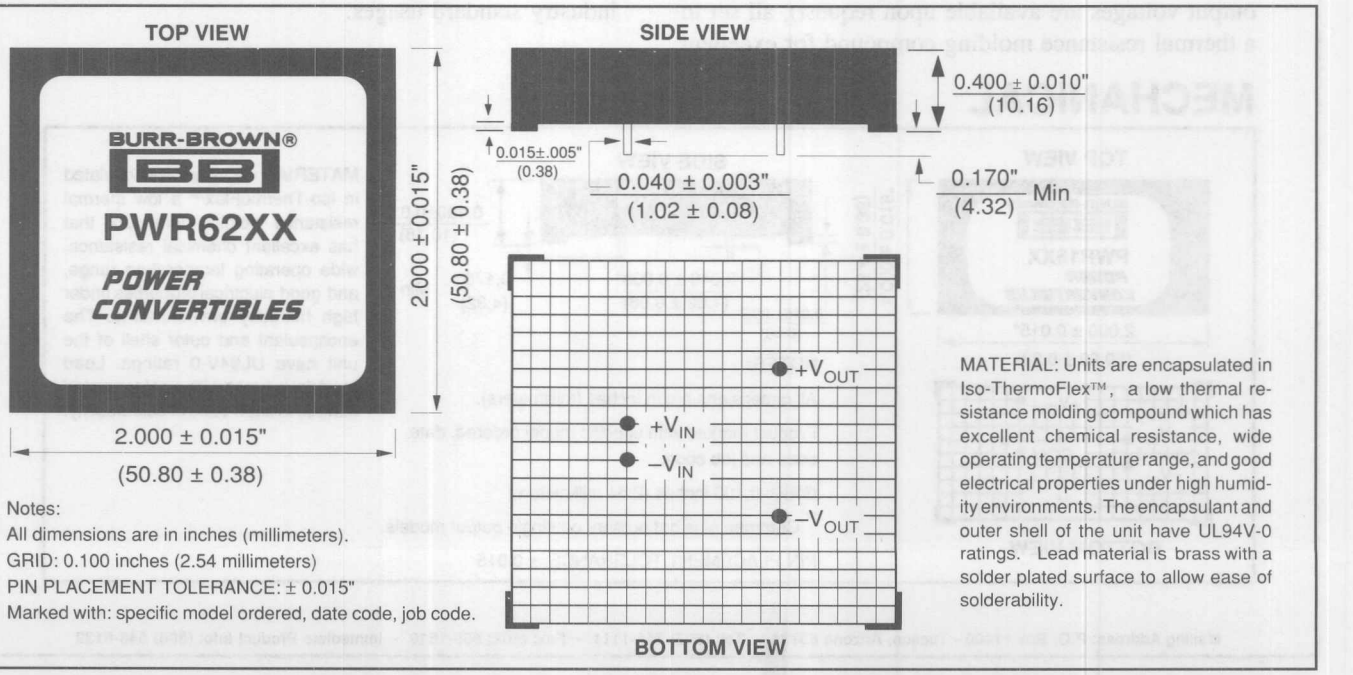
Specifications typical at T_A = +25°C, rated input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage	PWR6200	4.75	5.0	5.25	VDC
	PWR6201	10.80	12.0	13.20	VDC
	PWR6202	13.50	15.0	16.50	VDC
	PWR6203	21.60	24.0	26.50	VDC
	PWR6204	25.20	28.0	30.20	VDC
	PWR6205	43.20	48.0	52.80	VDC
Reflected Ripple Current			30.0		mAp-p
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60 Hz, 10 seconds	500			Vpk
Resistance			10		GΩ
Capacitance			80		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz			25	µArms
OUTPUT					
Rated Voltage			–5.2		VDC
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IIN}			±1	%
Temperature Coefficient			±0.02		%/°C
Rated Current			1000		mA
Rated Power			5.2		W
Ripple and Noise	BW = DC to 10MHz		25		mVp-p
REGULATION					
Line	High Line to Low Line		±0.04		%
Load	Rated Load to No Load		0.06		%
GENERAL					
Efficiency			68		%
Switching Frequency			170		kHz
Package Weight			50		g
MTTF per MIL-HDBK-217 Rev. E.	Circuit Stress Method		762,000		Hr
TEMPERATURE					
Specification		0	+25	+70	°C
Operating		-25		+85	°C
Storage		-40		+110	°C

ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration ..... Continuous
Internal Power Dissipation 3.5W
Lead Temperature (soldering, 10 seconds, max.) ..... +300°C

MECHANICAL



Notes:
All dimensions are in inches (millimeters).
GRID: 0.100 inches (2.54 millimeters)
PIN PLACEMENT TOLERANCE: ± 0.015"
Marked with: specific model ordered, date code, job code.

MATERIAL: Units are encapsulated in Iso-ThermoFlex™, a low thermal resistance molding compound which has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

BURR-BROWN®

PWR16XX SERIES

5-6 WATTS
UNREGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

HIGH-DENSITY, INDUSTRY STANDARD PACKAGE

FEATURES

- TYPICAL EFFICIENCY: 82%
- LOW COST
- INDUSTRY-STANDARD PACKAGE
- SINGLE AND DUAL OUTPUTS
- 100% NON-CONDUCTIVE CASE
- SIX-SIDED SHIELDING
- 20mVrms RIPPLE AND NOISE WITH NO EXTERNAL COMPONENTS

APPLICATIONS

- HIGH DENSITY PC BOARDS
- TEST EQUIPMENT
- PROCESS CONTROL
- COMPUTER PERIPHERALS

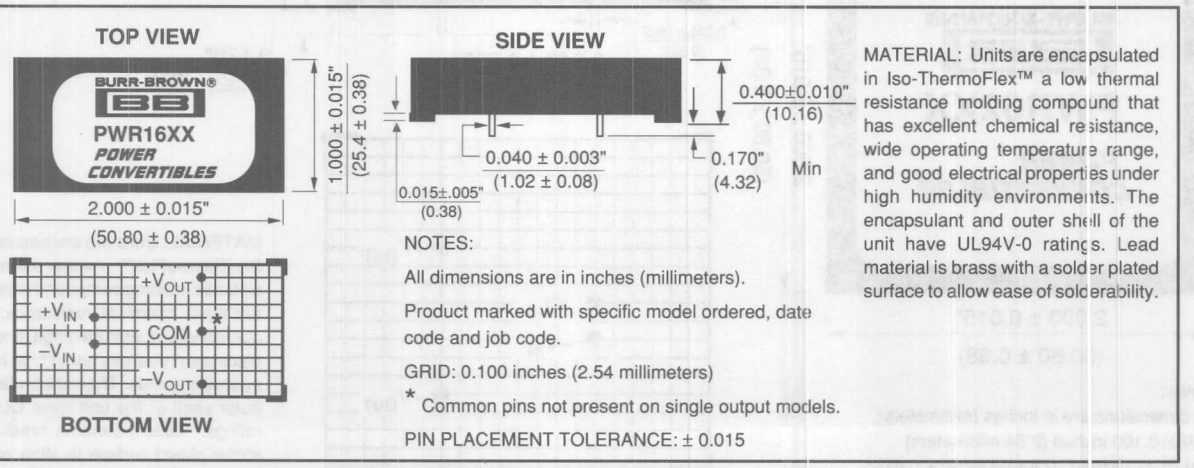
DESCRIPTION

The PWR16XX series of DC/DC converters give high power densities where space is critical and tight regulation is not. The small industry standard package (1"x2"x0.4") and pin-out are used to address the possibility of upgrading present end products. Designed for high-density boards, the package is non-conductive, which presents advantages over painted metal enclosures.

The series includes thirteen models (other input and output voltages are available upon request), all set in a thermal resistance molding compound for excellent heat dissipation for internal components. The use of surface mount devices and manufacturing processes, combined with the encapsulation process, provides the user a product that is environmentally rugged.

The PWR16XX has a full 500VDC isolation barrier between input and output to give the designer maximum flexibility in grounding options and polarity configurations. The outstanding MTTF, superior reliability, and low cost make it an excellent choice for industry standard usages.

MECHANICAL



NOTES:

All dimensions are in inches (millimeters).

Product marked with specific model ordered, date code and job code.

GRID: 0.100 inches (2.54 millimeters)

* Common pins not present on single output models.

PIN PLACEMENT TOLERANCE: ± 0.015

MATERIAL: Units are encapsulated in Iso-ThermoFlex™ a low thermal resistance molding compound that has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, rated input voltage, rated output current unless otherwise specified.

MODEL	MINIMUM INPUT VOLTAGE	RATED INPUT VOLTAGE	MAXIMUM INPUT VOLTAGE	RATED OUTPUT VOLTAGE	RATED OUTPUT CURRENT	INPUT CURRENT		REFLECTED RIPPLE CURRENT
						NO LOAD	FULL LOAD	
Units	VDC	VDC	VDC	VDC	mA	mA	mA	mAp-p
PWR1600	4.5	5.0	5.5	5	1000	50	1220	60
PWR1604	4.5	5.0	5.5	±12	±250	50	1460	60
PWR1605	4.5	5.0	5.5	±15	±200	50	1460	60
PWR1606	10.0	12.0	14.0	5	1000	30	510	60
PWR1607	10.0	12.0	14.0	12	500	30	610	60
PWR1610	10.0	12.0	14.0	±12	±250	30	610	60
PWR1611	10.0	12.0	14.0	±15	±200	30	610	60
PWR1612	13.0	15.0	17.0	5	1000	30	410	60
PWR1616	13.0	15.0	17.0	±12	±250	30	490	60
PWR1617	13.0	15.0	17.0	±15	±200	30	490	60
PWR1618	21.0	24.0	28.0	5	1000	30	260	60
PWR1622	21.0	24.0	28.0	±12	±250	30	305	60
PWR1623	21.0	24.0	28.0	±15	±200	30	305	60

Note: Other input to output voltages may be available. Please contact factory.

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, rated input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
OUTPUT					
Rated Power	5V Output Models		5.0		W
	All Other Output Models		6.0		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}		±3	±5	%
Temperature Coefficient			±0.05		%/°C
Ripple and Noise	BW = DC to 10MHz. No External Components		70		mVp-p
	BW = 10Hz to 20MHz. No External Components		20		mVrms
Voltage	No Load, V_{OUT} = +5			7	VDC
	No Load, V_{OUT} = ±12			±15	VDC
	No Load, V_{OUT} = ±15			±18	VDC
Line Regulation			1.0		%/%V_{IN}
Load Regulation			See Curves		
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60 Hz, 10 Seconds	500			Vpk
Resistance			10		GΩ
Capacitance			80		pF
Leakage Current	240VAC, 60Hz		5		µArms
GENERAL					
Switching Frequency			150		kHz
Package Weight			20		g
MTTF per MIL-HDBK-217, Rev. E	Circuit Stress Method		2,220,000		Hr
Efficiency			82		%
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–25		+100	°C
Storage		–40		+110	°C

ORDERING INFORMATION

PWR 16XX /H

Device Family
PWR indicates DC/DC converter

Model Number
Selected from table of Electrical Specifications

Screening Option

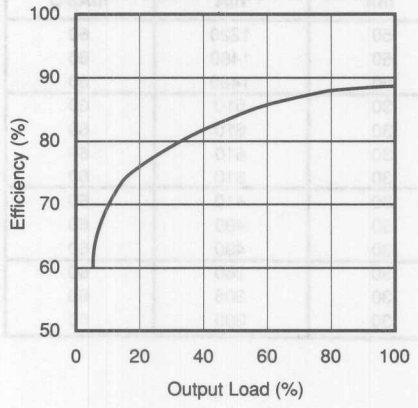
ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration ..... 10 seconds
Output Power
5V Output Models 5.0W
All Other Models 6.0W
Lead Temperature (soldering, 10seconds max) ..... +300°C
Internal Power Dissipation 1.67W

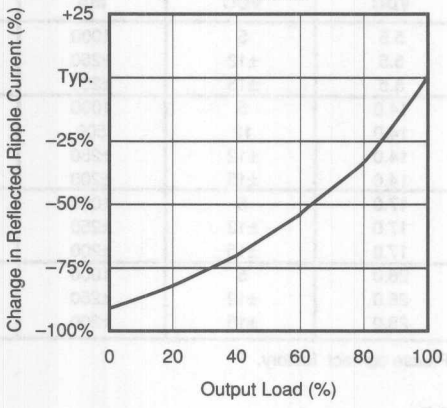
TYPICAL PERFORMANCE CURVES

T_A = +25°C, Rated Input Voltage, Rated Output Current unless otherwise noted.

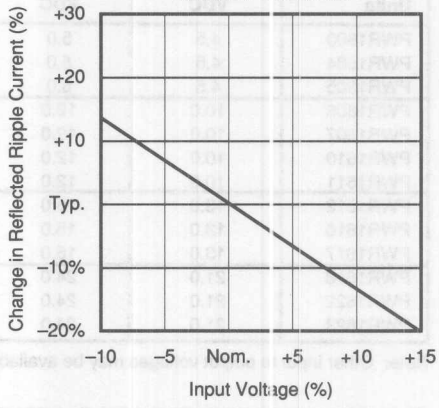
EFFICIENCY vs OUTPUT LOAD



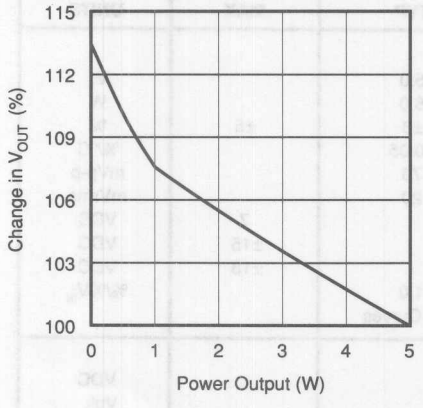
REFLECTED RIPPLE CURRENT vs LOAD



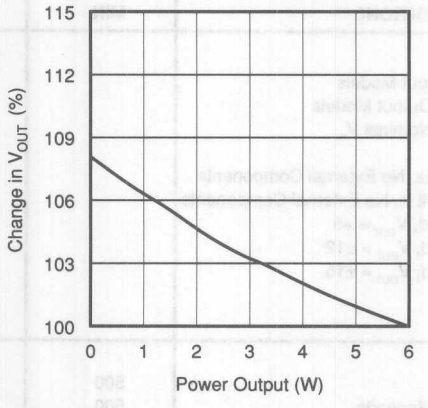
REFLECTED RIPPLE CURRENT vs INPUT VOLTAGE



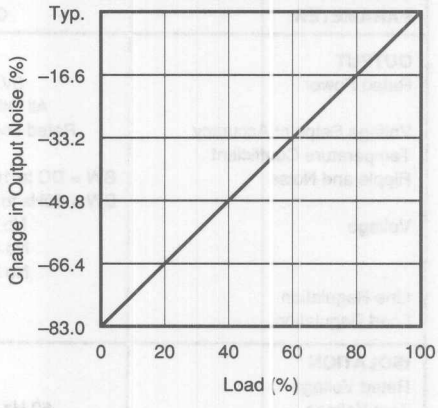
V_{OUT} vs P_{OUT} (SINGLES)



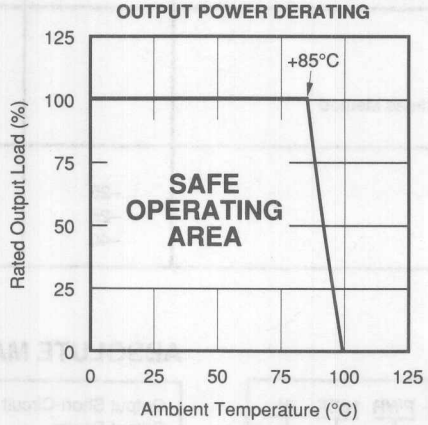
V_{OUT} vs P_{OUT} (DUALS)



OUTPUT NOISE vs OUTPUT LOAD



OUTPUT POWER DERATING



BURR-BROWN®

PWR51XX

9 WATTS REGULATED

POWER CONVERTIBLES™ DC/DC CONVERTERS

LOW NOISE, LOW COST

FEATURES

- LOW COST
- LOW NOISE
- LINEAR OUTPUT REGULATION
- WIDE OPERATING TEMPERATURE RANGE: –40°C TO +100°C
- ±12VDC AND ±15VDC OUTPUTS
- INPUT AND OUTPUT FILTERING
- SIX-SIDED SHIELDING
- BARRIER LEAKAGE CURRENT 100% TESTED AT 240VAC

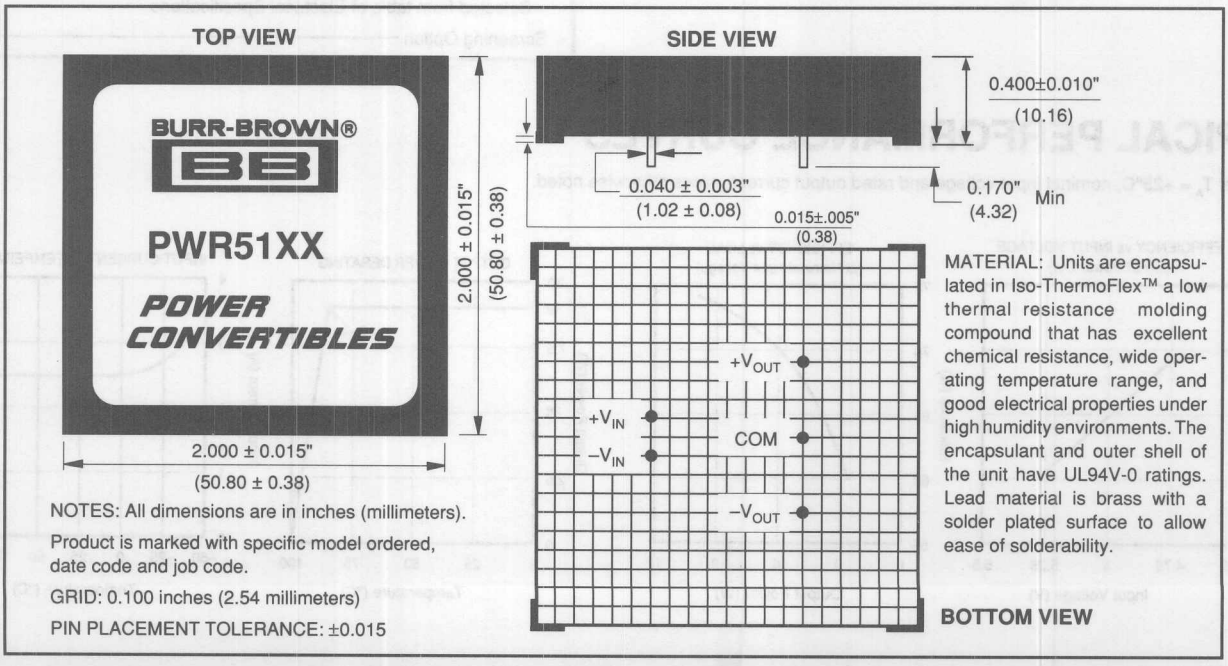
DESCRIPTION

The PWR5104 and PWR5105 offer respectively ±12VDC and ±15VDC outputs of regulated 9W power driven from your +5V system bus. These units are designed for use in such diverse applications as process control, telecommunications, portable equipment, medical systems, airborne and shipboard electronic circuits, and automatic test equipment.

The PWR5104 and PWR5105 offer a low-cost alternative to other models currently on the market. In addition, these models utilize high frequency switching in order to maintain a low EMI and RFI environment. Both models incorporate input and output filtering along with six-sided shielding to keep unwanted noise from your circuit.

Surface-mounted devices and manufacturing processes are used in the PWR5104 and PWR5105 to give you a device that is environmentally rugged. These manufacturing and design technologies also give superior isolation voltage.

MECHANICAL



NOTES: All dimensions are in inches (millimeters).

Product is marked with specific model ordered, date code and job code.

GRID: 0.100 inches (2.54 millimeters)

PIN PLACEMENT TOLERANCE: ±0.015

MATERIAL: Units are encapsulated in Iso-ThermoFlex™ a low thermal resistance molding compound that has excellent chemical resistance, wide operating temperature range, and good electrical properties under high humidity environments. The encapsulant and outer shell of the unit have UL94V-0 ratings. Lead material is brass with a solder plated surface to allow ease of solderability.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage and rated output current unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Nominal Voltage			5		VDC
Voltage Range		4.75		5.25	VDC
Input Current	No Load		60		mA
	Rated Load		2400	2570	mA
Ripple Current	Rated Load		5		mAp-p
OUTPUT					
PWR5104 Rated Voltage			±12		VDC
Rated Current				±375	mA
PWR5105 Rated Voltage			±15		VDC
Rated Current				±300	mA
Setpoint Accuracy	Rated Load, Nominal V_{IN}		±0.5	±1.0	%
Voltage Balance			±0.3		%
Temperature Coefficient	–25°C to +85°C		±0.01		%/°C
Ripple and Noise	BW = DC to 10MHz		6	35	mVp-p
Line Regulation			0.02		%
Load Regulation			0.04		%
Efficiency		70	75		%
ISOLATION					
Rated Voltage		750			VDC
Test Voltage	60 Hz, 10 Seconds	750			mVp-p
Resistance			10		GΩ
Capacitance			50		pF
Leakage Current	240Vrms, 60Hz			15	µArms
GENERAL					
Switching Frequency			50		kHz
Package Weight			50		g
MTTF per MIL-HDBK-217, Rev. E	Circuit Sress Method				kHr
TEMPERATURE					
Specification		–25	+25	+85	°C
Operation		–40		+100	°C
Storage		–55		+125	°C

Note: Other input to output voltages may be available. Please consult factory.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	18VDC
Output Short-Circuit Duration	15 seconds
Internal Power Dissipation	2W
Lead Temperature (soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

PWR 510X /H

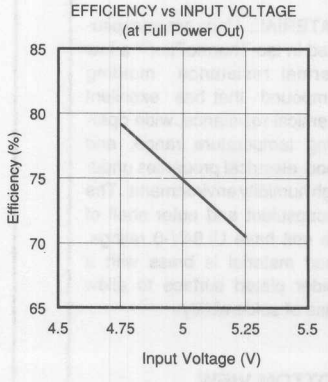
Device Family
PWR indicates DC/DC converter

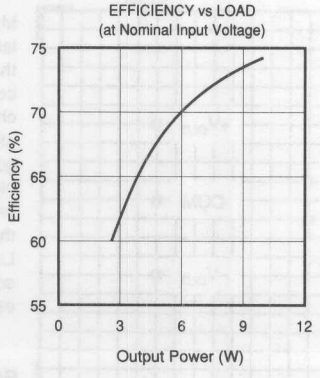
Model Number
Selected from table of Electrical Specifications

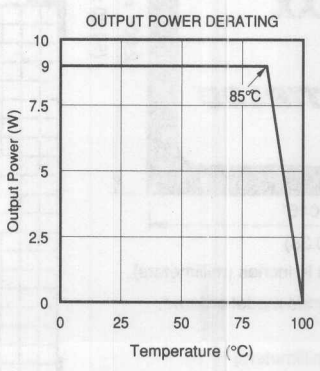
Screening Option

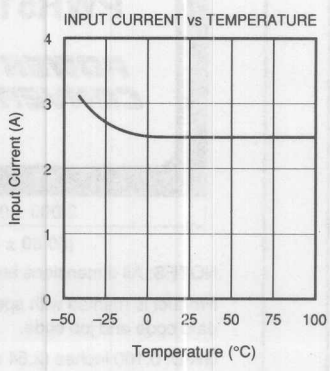
TYPICAL PERFORMANCE CURVES

Typical at T_A = +25°C, nominal input voltage and rated output current unless otherwise noted.









BURR-BROWN®

PWR53XX SERIES

15 WATTS
REGULATED

POWER CONVERTIBLES™ | **DC/DC CONVERTERS**

WIDE INPUT VOLTAGE RANGE, SINGLE, DUAL & TRIPLE OUTPUTS

FEATURES

- EXTENDED TEMPERATURE RANGE: -40° TO +85°
- HIGH EFFICIENCY: >80%
- SHORT-CIRCUIT PROTECTION
- SIX-SIDED SHIELDING
- REMOTE ON/OFF
- SURFACE MOUNT CONSTRUCTION

APPLICATIONS

- TELECOMMUNICATIONS EQUIPMENT
- BATTERY POWERED SYSTEMS
- PORTABLE INSTRUMENTS
- PROCESS CONTROL EQUIPMENT
- TRANSPORTATION EQUIPMENT

DESCRIPTION

The PWR53XX Series is a family of wide input range DC/DC converters that accept either 9.2 to 18VDC, 18 to 36VDC, or 36 to 72VDC depending on the model selected. A fixed-frequency, 200kHz-driven, push-pull oscillator input stage is used to ensure predictable and controlled performance. This eliminates the high peak voltages or currents present in other topologies, which reduce reliability.

A two-section pi-filter is used in the input stage to reduce reflected ripple current to a typical level of 30mAp-p. The design of this filter network also ensures stable frequency response of the PWR53XX Series, regardless of input voltage or output load current. Six-sided shielding suppresses electromagnetic radiation, which may disturb sensitive analog measurements or interfere with system timing signals.

All PWR53XX models will operate safely even at no load up to a temperature of 55°C, although there is a minimum load established for regulation measurements,

The controller used in the input stage of the PWR53XX Series has been designed to provide cycle-by-cycle current limiting for continuous short-circuit protection. In addition, it features soft-start, maximum duty cycle control, under-voltage lockout, and fully latched logic, which incorporates double pulse suppression. These features guarantee controlled, predictable operation to enhance unit reliability even under adverse operating conditions.

Rugged MOSPOWER transistors permit higher frequency operation (200kHz) with less complicated drive circuitry than is possible with bipolar power transistors. Reduced parts count adds to the PWR53XX Series' reliability.

The PWR53XX Series offers exceptional line and load regulation over the full input voltage and output load current range and not just some fractional portion. The output stage of the PWR53XX Series is designed to solve the problems associated with closing a control loop across a voltage isolation barrier. It is a more stable and reliable alternative to a simple optical coupler. Transformer isolation between the output stage and the input oscillator preserves barrier isolation without the degradation over time that is inherent with some optical couplers. The voltage reference and gain stage of this output circuit make it possible for the PWR53XX to offer such exceptional regulation.

Mailing Address: P.O. Box 11400 - Tucson, Arizona 85734 - Tel: (602) 746-1111 - Fax: (602) 889-1510 - Immediate Product Info: (800) 548-6132

ELECTRICAL SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

MODEL	NOMINAL INPUT VOLTAGE (VDC)	RATED OUTPUT VOLTAGE (VDC)	OUTPUT CURRENT		INPUT CURRENT		EFFICIENCY (%)
			MIN LOAD (A)	RATED LOAD (A)	MIN LOAD (mA)	RATED LOAD (mA)	
PWR5300	12	5	0.75	3	750	1540	81
PWR5301	12	12	0.32	1.25	750	1540	81
PWR5302	12	15	0.25	1	750	1540	81
PWR5303	24	5	0.75	3	375	750	83
PWR5304	24	12	0.32	1.25	375	750	83
PWR5305	24	15	0.25	1	375	750	83
PWR5306	48	5	0.75	3	185	375	83
PWR5307	48	12	0.32	1.25	185	375	83
PWR5308	48	15	0.25	1	185	375	83
PWR5309	12	±5	±0.375	1.5	750	1540	81
PWR5310	12	±12	±0.156	±0.625	750	1540	81
PWR5311	12	±15	±0.125	±0.5	750	1540	81
PWR5312	24	±5	±0.375	±1.5	375	750	83
PWR5313	24	±12	±0.156	±0.625	375	750	83
PWR5314	24	±15	±0.125	±0.5	375	750	83
PWR5315	48	±5	±0.375	±1.5	185	375	83
PWR5316	48	±12	±0.156	±0.625	185	375	83
PWR5317	48	±15	±0.125	±0.5	185	375	83
PWR5318	12	5, ±12	0.375, ±0.077	1.5, ±0.31	750	1540	81
PWR5319	12	5, ±15	0.375, ±0.063	1.5,±0.25	750	1540	81
PWR5320	12	5, 12,-5	0.375, 0.077, -0.125	1.5, 0.31, -0.5	750	1540	81
PWR5321	24	5, ±12	0.375, ± 0.077,	1.5, ±0.31	375	750	83
PWR5322	24	5, ±15	0.375, ±0.063,	1.5, ±0.25	375	750	83
PWR5323	24	5, 12,-5	0.375, 0.077, -0.125	1.5, 0.31, -0.5	375	750	83
PWR5324	48	5, ±12	0.375, ± 0.077,	1.5,±0.31	185	375	83
PWR5325	48	5, ±15	0.375, ±0.063	1.5,±0.25	185	375	83
PWR5326	48	5, 12,-5	0.375, 0.077, -0.125	1.5, 0.31, -0.5	185	375	83

COMMON SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

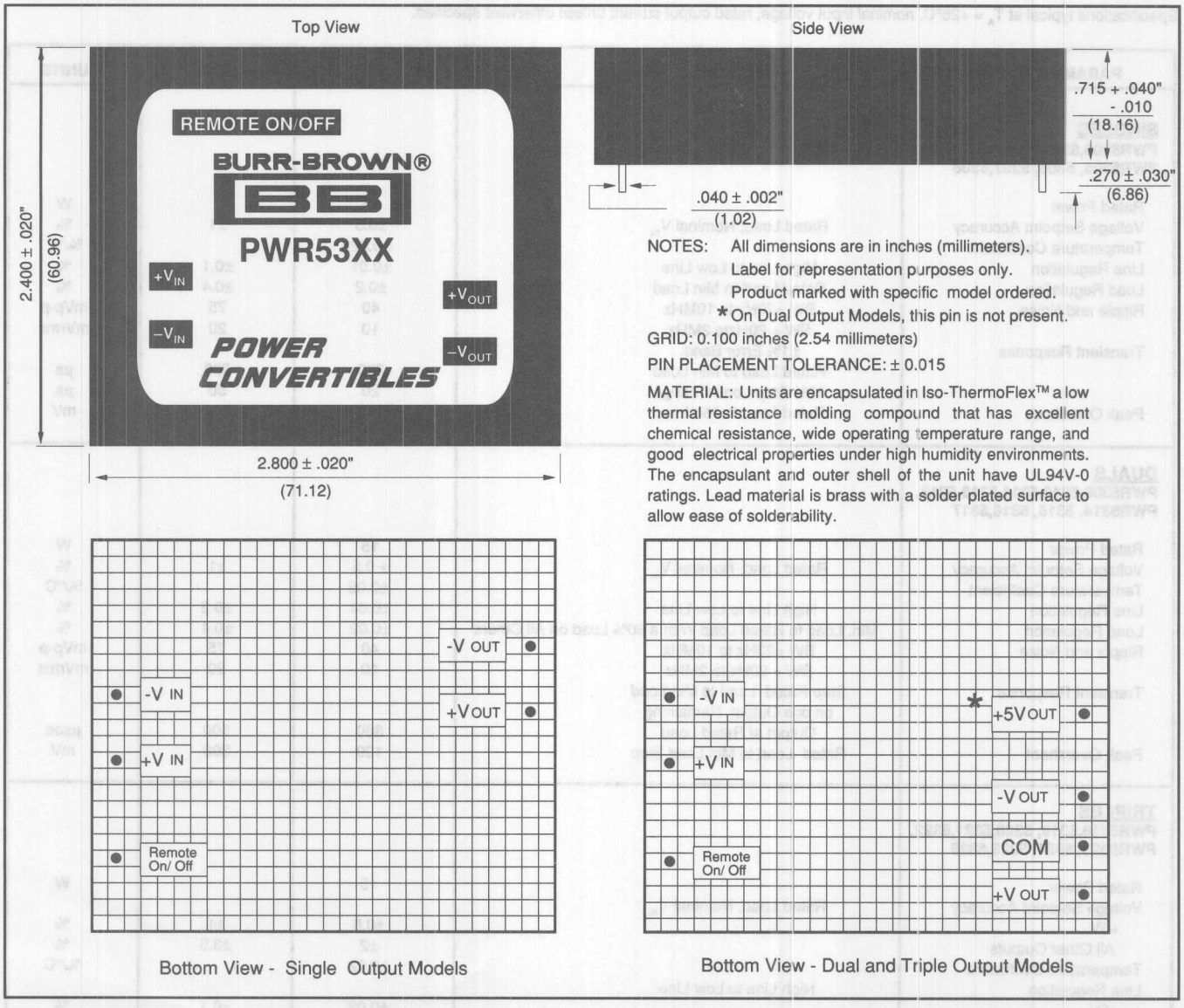
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT					
Voltage Range		9.2	12	18	VDC
		18	24	36	VDC
		36	48	72	VDC
Reflected Ripple Current			30		mAp-p
ISOLATION					
Rated Voltage		500			VDC
Test Voltage	60 Hz, 10 Seconds	500			Vpk
Resistance			10		GΩ
Capacitance			200		pF
Leakage Current	V_{ISO} = 240VAC, 60Hz		30		µArms
GENERAL					
Switching Frequency			200		kHz
Phase Margin			55		Degrees
Package Weight			130		g
MTTF per MIL-HDBK-217, Rev. E	Circuit Stress Method				
Ground Benign			400		kHr
Fixed Ground			140		kHr
Naval Sheltered			90		kHr
Airborne Uninhabited Fighter			26		kHr
TEMPERATURE	**Minimum Load Required**				
Specification	No Power Derating	-25		+85	°C
Operation		-40		+90	°C
Storage		-40		+110	°C

OUTPUT SPECIFICATIONS

Specifications typical at T_A = +25°C, nominal input voltage, rated output current unless otherwise specified.

PARAMETER	CONDITIONS	TYP	MAX	UNITS
SINGLES				
PWR5300,5301,5302,5303,5304, PWR5305, 5306, 5307,5308				
Rated Power		15		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}	±0.5	±1	%
Temperature Coefficient		±0.02		%/°C
Line Regulation	High Line to Low Line	±0.01	±0.1	%
Load Regulation	Rated Load to Min Load	±0.2	±0.4	%
Ripple and Noise	BW =20Hz to 10MHz	40	75	mVp-p
	BW = 20Hzto 2MHz	10	20	mVrms
Transient Response	±1% Error Band,			
	Rated Load to Min Load	300	500	µs
	25% Step Load Change	20	50	µs
Peak Overshoot	Rated Load to Min Load	190	300	mV
DUALS				
PWR5309,5310,5311,5312,5313, PWR5314, 5315, 5316,5317				
Rated Power		15		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}	± 0.5	±1	%
Temperature Coefficient		±0.02		%/°C
Line Regulation	High Line to Low Line	±0.04	±0.2	%
Load Regulation	Min. Load to Rated Load With a 60% Load on All Others	±0.02	±0.4	%
Ripple and Noise	BW =20Hz to 10MHz	40	75	mVp-p
	BW = 20Hz to 2MHz	10	20	mVrms
Transient Response	Step Rated Load to Min Load on one Output, Remaining			
	Output at Rated Load	300	500	µsec
Peak Overshoot	Rated Load to Min Load Step	100	300	mV
TRIPLES				
PWR5318,5319, 5320,5321,5322, PWR5323, 5324, 5325,5326				
Rated Power		15		W
Voltage Setpoint Accuracy	Rated Load, Nominal V_{IN}			
+5V		±0.5	±1	%
All Other Outputs		±2	±3.5	%
Temperature Coefficient		±0.02		%/°C
Line Regulation	High Line to Low Line			
+5V		±0.02	±0.1	%
All Other Outputs		±0.3	±1	%
Load Regulation	5V Min. Load to Rated Load with a 60%Load on All Others			
+5V		±0.2	±0.4	%
$\pm V_{OUT}$		±1.2	±2	%
Ripple and Noise	BW = 20Hz to 10MHz	40	75	mVp-p
	BW = 20Hz to 2MHz	10	20	mVrms
Transient Response	Step Rated Load to Min Load on Indicated Output, Remaining Outputs at Rated Load	350	420	µsec
Peak Overshoot	Rated Load to Min Load Step			
+5V		600	825	mV

MECHANICAL



ABSOLUTE MAXIMUM RATINGS

Output Short-Circuit Duration	Continuous
Internal Power Dissipation	4.5W
Lead Temperature (soldering, 10 seconds max)	+300°C

ORDERING INFORMATION

PWR 53XX /H

Device Family — PWR indicates DC/DC converter

Model Number — Selected from Electrical Specification Table

Screening Option

REMOTE ON/OFF

Logic Compatibility	CMOS or Open Collector TTL
E_c On	+5VDC or Open Circuit
E_c Off	1.7VDC
Shutdown Idle Current	35mA
Input Resistance To Remote On/Off	100kΩ
Control Common	Referenced to Input Minus

BURR-BROWN®

PWS740

Distributed Multichannel Isolated DC-TO-DC CONVERTER COMPONENTS

FEATURES

- ISOLATED ±7 TO ±20VDC OUTPUTS
- BARRIER 100% TESTED AT 1500VAC, 60Hz
- MINIMUM PC BOARD SPACE
- 80% EFFICIENCY (8 CHANNELS, RATED LOADS)

APPLICATIONS

- INDUSTRIAL MEASUREMENT AND CONTROL
- DATA ACQUISITION SYSTEMS
- TEST EQUIPMENT

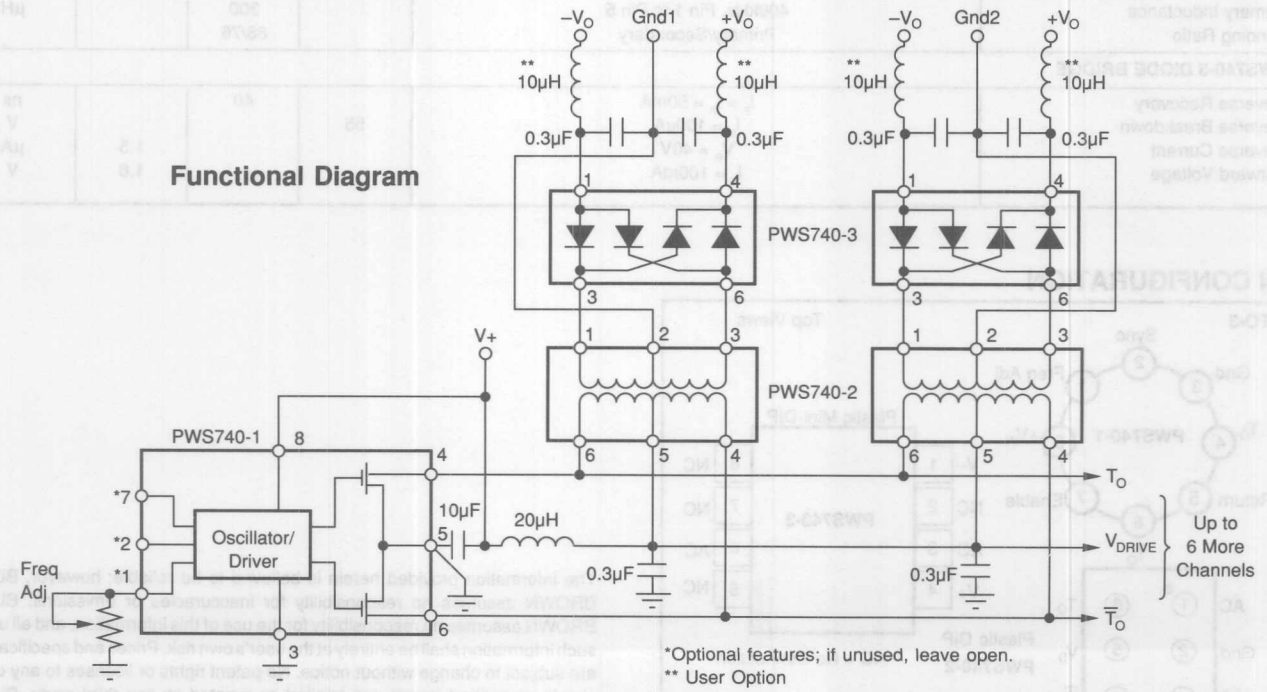
DESCRIPTION

The PWS740 is a multichannel, isolated DC-to-DC converter with a 1500VAC continuous isolation rating. The outputs track the input voltage to the converter over the range of 7 to 20VDC. The converter's modular design, comprising three components, minimizes the cost of isolated multichannel power for the user.

The PWS740-1 is a high-frequency (400kHz nominal) oscillator/driver, handling up to eight channels. This part is a hybrid containing an oscillator and two power FETs. It is supplied in a TO-3 case to provide the power dissipation necessary at full load. Transformer impedance limits the maximum input current to about 700mA at 15V input, well within the unit's thermal limits. A TTL-compatible ENABLE pin provides output shut-down if desired. A SYNC pin allows synchronization of several PWS740-1s.

The PWS740-2 is a trifilar-wound isolation transformer using a ferrite core and is encapsulated in a plastic package, allowing a higher isolation voltage rating. The PWS740-3 is a high-speed rectifier bridge in a plastic 8-pin mini-DIP package. One PWS740-2 and one PWS740-3 are used per isolated channel.

Functional Diagram



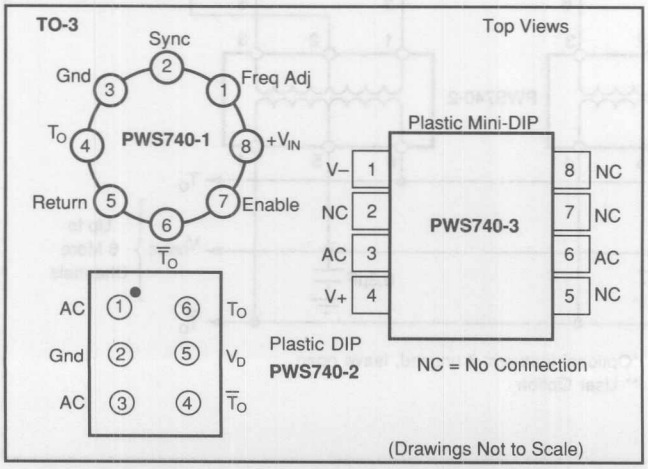
SPECIFICATIONS

ELECTRICAL

V_{IN} = 15V, output load on each of 8 channels = ±15mA, T_A = +25°C unless otherwise specified.

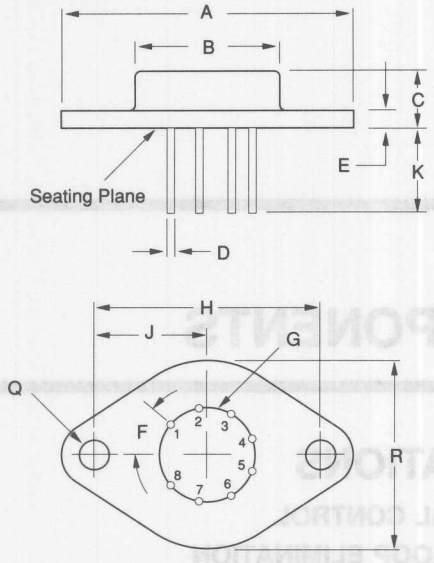
PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
PWS740 SYSTEM					
ISOLATION					
Rated Voltage	Continuous, AC, 50/60Hz			1500	VACrms
	Continuous, DC			2121	VDC
Test Voltage	10s, minimum	4000			VACrms
Impedance	Measured from Pin 2 to Pin 5 of the PWS740-2		10^{12} || 3		Ω || pF
Leakage Current	240VACrms, 60Hz Per Channel		0.5	1.5	µA
INPUT					
Rated Voltage			15		VDC
Voltage Range		7		20	VDC
Current	±30mA Output Load on 8 Channels, V_{IN} = 15V		520		mA
	Rated Output Load on 8 Channels, V_{IN} = 15V		300		mA
Current Ripple	Full Output Load on 8 Channels, V_{IN} = 15V with π Filter on Input		1		mA
OUTPUT					
Rated Voltage	±15mA Output Load on 8 Channels	14	15	16.5	VDC
Voltage at Min Load	±1mA/Channel		30		VDC
Voltage Range	±15mA Output Load on Each Channel	±7		±20	VDC
V_{OUT} vs Temp	±15mA Output Load on Each Channel		±0.05		V/°C
Load Regulation	±3mA < Output Load < ±30mA		0.25		V/mA
Tracking Regulation	V_{OUT}/V_{IN}		1.2		V/V
Ripple Voltage	See Typical Performance Curves				
Noise Voltage	See Theory of Operation				
Current | $+I_{OUT}$ | + | $-I_{OUT}$ |	Each Channel			60	mA
TEMPERATURE					
Specification		–25		+85	°C
Operation		–25		+85	°C
PWS740-1 OSCILLATOR/DRIVER					
Frequency	V_{IN} = 15V	350	400	470	kHz
Supply		7	15	20	V
Enable	Drivers On	2		V_S	V
	Drivers Off	0		0.8	V
PWS740-2 ISOLATION TRANSFORMER					
Isolation Test Voltage	10s, minimum	4000			VACrms
	60s, minimum	1500			VACrms
Rated Isolation Voltage	Continuous			1500	VACrms
Isolation Impedance			10^{12} || 3		Ω || pF
Isolation Leakage	240VAC		0.5	1.5	µA
Primary Inductance	400kHz, Pin 1 to Pin 5		300		µH
Winding Ratio	Primary/Secondary		68/76		
PWS740-3 DIODE BRIDGE					
Reverse Recovery	$I_F = I_R$ = 50mA		40		ns
Reverse Breakdown	I_R = 100µA	55			V
Reverse Current	V_R = 40V			1.5	µA
Forward Voltage	I_F = 100mA			1.6	V

PIN CONFIGURATION



MECHANICAL

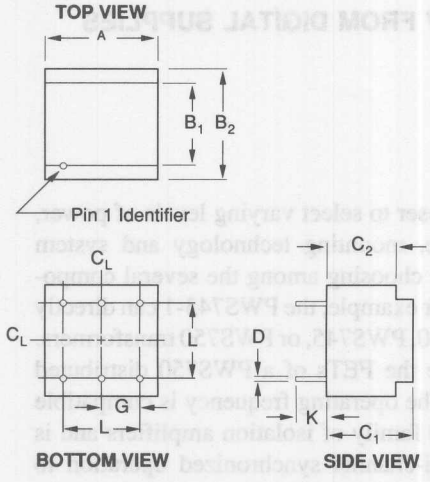
M Package — TO-3



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.510	1.550	38.35	39.37
B	.745	.770	18.92	19.56
C	.260	.340	6.60	8.64
D	.038	.042	0.97	1.07
E	.080	.105	2.03	2.67
F	40° BASIC		40° BASIC	
G	.500 BASIC		12.70 BASIC	
H	1.186 BASIC		30.12 BASIC	
J	.593 BASIC		15.06 BASIC	
K	.400	.500	10.16	12.70
Q	.151	.161	3.84	4.09
R	.980	1.020	24.89	25.91

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane. Pin numbers shown for reference only. Numbers may not be marked on package.

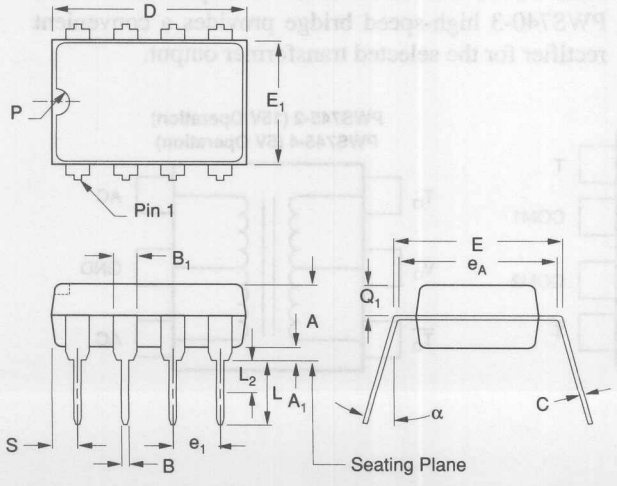
P-Package — 6-Pin Plastic DIP



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.54	0.64	13.72	16.26
B_1	0.39	0.49	9.91	12.45
B_2	0.54	0.64	13.72	16.26
C_1	0.39	0.52	9.91	13.21
C_2	0.29	0.44	7.37	11.18
D	.020	.030	0.50	0.76
G	.200 BASIC		5.08 BASIC	
K	0.11	0.21	2.79	5.33
L	.400 BASIC		10.16 BASIC	

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane.3.2).

P Package — 8-Pin Plastic DIP



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.155	.200	3.94	5.08
A_1	.020	.050	0.51	1.27
B	.014	.020	0.36	0.51
B_1	.045	.065	1.14	1.65
C	.008	.012	0.20	0.30
D (1)	.370	.400	9.40	10.16
E	.300	.325	7.62	8.26
E_1	.240	.260	6.10	6.60
e_1	.100 BASIC		2.54 BASIC	
e_A	.300 BASIC		7.62 BASIC	
L	.125	.150	3.18	3.81

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
L_2 (2)	0	.030	0.00	0.76
α	0°	15°	0°	15°
P	.015	.050	0.38	1.270
Q_1	.040	.075	1.02	1.91
S (1)	.015	.050	0.38	1.27

(1) Not JEDEC Std.
(2) e_1 and e_A apply in zone L_2 when unit installed.
NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane.

BURR-BROWN®

PWS745

Multi-Channel DC/DC CONVERTER COMPONENTS

FEATURES

- COMPACT SIZE
- LOW COST PER CHANNEL
- DRIVES UP TO 8 CHANNELS
- 750/1500VAC ISOLATION
- FLEXIBLE USE WITH PWS740/PWS750 COMPONENTS
- 0.4 IN. MAXIMUM MOUNTING HEIGHT

APPLICATIONS

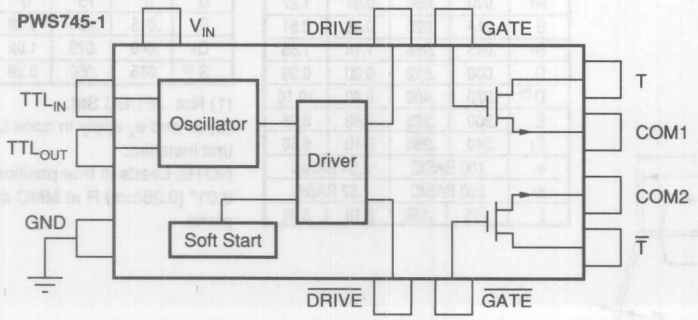
- INDUSTRIAL CONTROL
- GROUND-LOOP ELIMINATION
- PC-BASED DATA ACQUISITION
- POINT-OF-USE POWER CONVERSION
- 5V TO ±15V FROM DIGITAL SUPPLIES

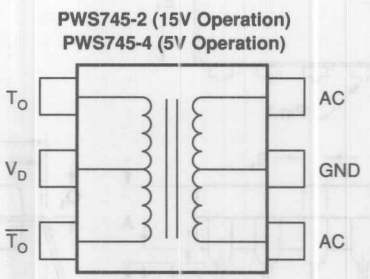
DESCRIPTION

The PWS745 is a set of components useful in the construction of single or multi-channel isolated DC/DC converters. By themselves, or in combination with the PWS740 and PWS750 families of components, they allow compact, optimal, and low-cost solutions to many power supply problems.

The PWS745-1 DIP oscillator/driver can be used to drive up to eight channels of independently isolated power. The switching MOSFETs are built into the driver to allow simple low-cost assembly of the multi-channel converter. The PWS745-1 also is capable of operating at 5VDC and can be easily synchronized with TTL level signals. While offering the user an alternative to the TO-3 package of the PWS740, the PWS745-1 also allows the user to select varying levels of power, isolation voltage, mounting technology and system configuration by choosing among the several component families. For example, the PWS745-1 can directly drive the PWS740, PWS745, or PWS750 transformers. It also can drive the FETs of a PWS750 distributed power system. The operating frequency is compatible with the ISO120 family of isolation amplifiers and is capable of multi-channel synchronized operation to eliminate troublesome beat frequencies.

The PWS745-2 is a 15V to ±15V output version, while the PWS745-4 is the 5V to ±15V output version. The PWS740-3 high-speed bridge provides a convenient rectifier for the selected transformer output.





SPECIFICATIONS

ELECTRICAL

At V_{IN} = 15VDC, Output Load = ±15mA (PWS745-2) and T_A = 25°C unless otherwise noted.
Or V_{IN} = 5VDC, Output Load = ±12mA (PWS745-4) and T_A = 25°C unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
PWS745-1 OSCILLATOR/DRIVER					
Frequency: Internal OSC	TTL_{IN} = 0V	550	600	650	kHz
External OSC		500	600	1000	kHz
Supply: 15V Operation		10	15	18	V
5V Operation		4.5	5	5.5	V
Current	No Load		10		mA
	Max Load		650		mA
Current Ripple	C_{BYPASS} = 1µF		2.5		mAp-p
TTL_{IN}: I_{IH}				10	nA
I_{IL}			–1		µA
V_{IH}		2			V
V_{IL}				0.8	V
Frequency		1		2	MHz
TTL_{OUT}: I_{OL}				15	mA
Frequency			600		kHz
T, $\overline{T}$ Drive Current				50	mA
T, $\overline{T}$ Drive Voltage: High		3		7	V
Low				0.7	V
PWS745-2					
Voltage, Rated Continuous AC 60Hz		750			Vrms
100% Test(1)	60Hz, 1s	1200			Vrms
Barrier Impedance			10^{12} || 8		Ω || pF
Leakage Current at 60Hz	V_{ISO} = 240Vrms, 60Hz			150	µArms
PWS745-4					
Voltage, Rated Continuous AC 60Hz		750			Vrms
100% Test(1)	60Hz, 1s	1200			Vrms
Barrier Impedance			10^{12} || 8		Ω || pF
Leakage Current at 60Hz	V_{ISO} = 240Vrms, 60Hz			150	µArms
TEMPERATURE RANGE					
Specification		–40		85	°C
Operation		–40		85	°C
Storage		–40		85	°C

NOTES: (1) Tested at 1.6 rated, fail on 5pc partial discharge leakage current on five successive pulses.

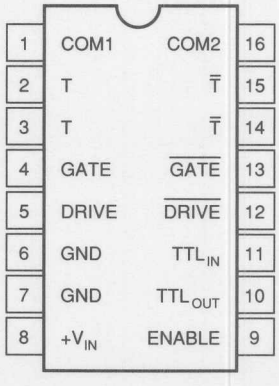
ABSOLUTE MAXIMUM RATINGS

Supply Voltage 18V
Continuous Isolation Voltage 750Vrms
Junction Temperature ..... 150°C
Storage Temperature ..... 85°C
Lead Temperature (soldering, 10s) ..... 300°C
Transformer Output Short to Common ..... Continuous
Max Load, Sum of All Transformer Outputs 500mA

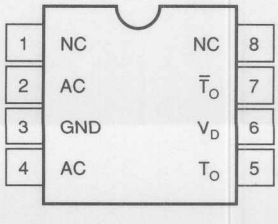
Stresses above these ratings may permanently damage the device.

PIN CONFIGURATIONS

PWS745-1

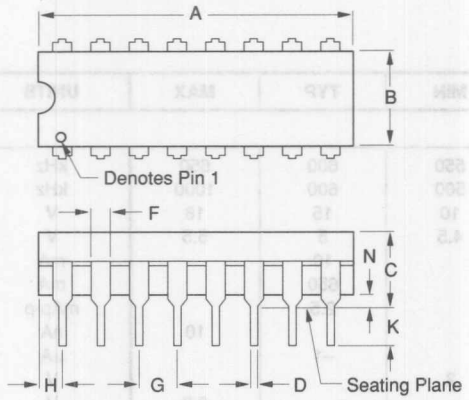


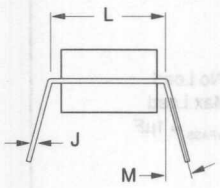
PWS745-2/PWS745-4



MECHANICAL

PWS745-1 — 16-Pin Plastic DIP

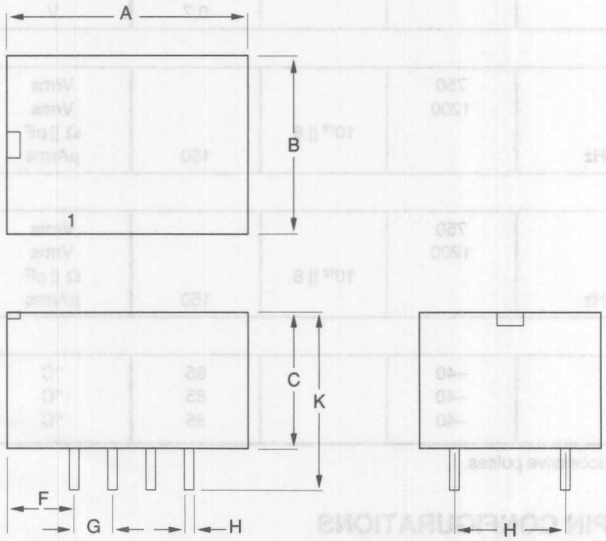




DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	.760	.885	19.30	22.48
B	.220	.280	5.59	7.11
C	—	.200	—	5.08
D	.015	.023	0.38	0.58
F	.030	.070	0.76	1.78
G	.100	BASIC	2.54	BASIC
H	.030	.095	0.76	2.41
J	.008	.015	0.20	0.38
K	.100	—	2.54	—
L	.300	BASIC	7.62	BASIC
M	—	15°	—	15°
N	.020	.050	0.51	1.27

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane.

Package — 8-Pin Plastic



DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	.620	.640	15.78	16.26
B	.465	.485	11.81	12.32
C	.350	.370	8.89	9.40
F	.165	.185	4.19	4.70
G	.100	BASIC	2.54	BASIC
H	.025	SQ.	.635	SQ.
K	.470	.490	11.94	12.45
L	.280	.300	7.11	7.62

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane. Pin numbers shown for reference only. Numbers may not be marked on package.

BURR-BROWN®

PWS750

Isolated, Unregulated DC/DC CONVERTER COMPONENTS

FEATURES

- 100% TESTED FOR HIGH-VOLTAGE BREAKDOWN
- COMPACT-SURFACE MOUNT
- MULTICHANNEL OPERATION
- 5V OR 15V INPUT OPTIONS

APPLICATIONS

- INDUSTRIAL PROCESS CONTROL EQUIPMENT
- GROUND-LOOP ELIMINATION
- PC-BASED DATA ACQUISITION
- VENDING MACHINES

DESCRIPTION

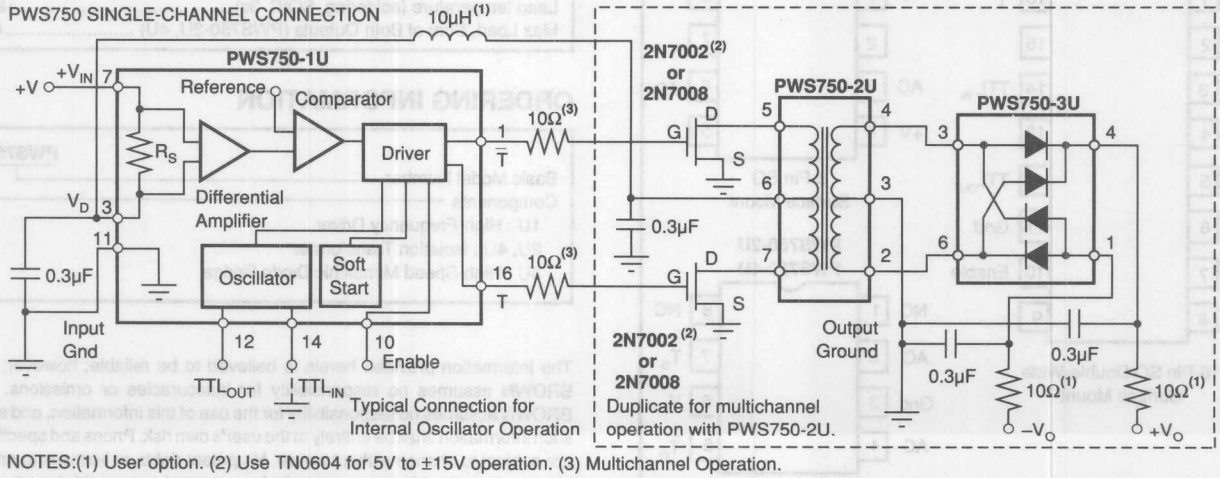
The PWS750 consists of three building blocks for building a low cost DC/DC converter. With them you can optimize DC/DC converter PC board layout or build a multichannel isolated DC/DC converter. All parts are surface mount, requiring minimal space to build the converter. The modular design minimizes the cost of isolated power.

The PWS750-1U is a high-frequency (800kHz nominal) driver that can drive N-channel MOSFETs up to the size of a 1.3A 2N7010. The recommended MOSFET for individual transformer drivers is the 2N7008. The PWS750-1U is supplied in a 16-pin double-wide SO package.

The PWS750-2U and PWS750-4U are split-bobbin wound isolation transformers using a ferrite core. They are encapsulated in plastic packages, allowing a high isolation voltage rating.

The PWS750-3U is a high-speed monolithic diode bridge in a plastic 8-pin SO package.

One PWS750-1U can be used to drive up to four channels (15V nominal operation). One PWS750-2U and PWS750-3U and two 2N7002 (surface mount) or 2N7008 (TO-92) MOSFETs made by Siliconix are used per isolated channel. When a PWS750-4U is used as the transformer (5V input), then two TN0604s made by Supertex must be used, due to the higher currents of the primary (lower RDS on) and the lower V_{GS} threshold. With 5V operation only one channel can be directly driven by the PWS750-1U (a simple FET booster circuit can be used for multichannel operation; see Figure 3).



NOTES:(1) User option. (2) Use TN0604 for 5V to ±15V operation. (3) Multichannel Operation.

SPECIFICATIONS

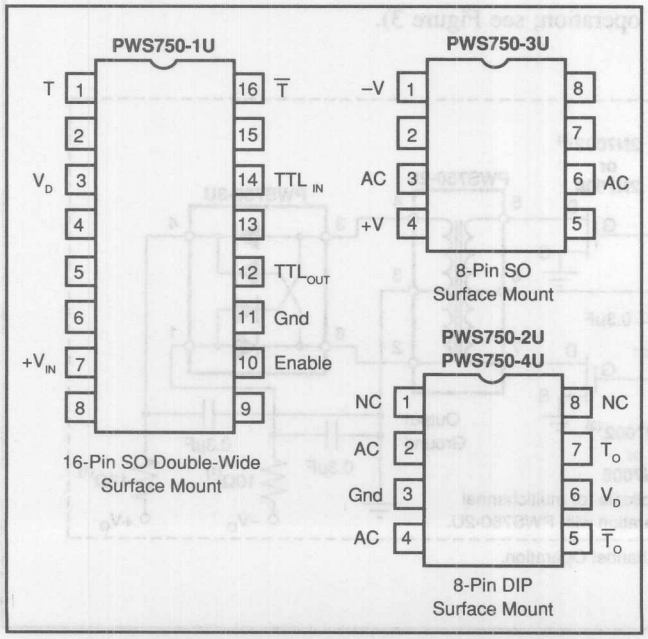
ELECTRICAL

At T_A = 25°C; $+V_{IN}$ = +15V; and I_{OUT} = ±15mA balanced loads unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
PWS750-1U OSCILLATOR					
Frequency: Internal OSC	TTL_{IN} = 0V	725	800	875	kHz
External OSC		1		2.5	MHz
Supply: 15V Operation		10	15	18	V
5V Operation		4.5	5	5.5	V
T, $\overline{T}$ Drive Current				50	mApk
T, $\overline{T}$ Drive Voltage, High		3		7	V
Low				0.7	V
TTL_{IN}, I_{IH}			10		nA
I_{IL}			–1		µA
V_{IH}		2			V
V_{IL}				0.8	V
TTL_{OUT}, I_{OL}				15	mA
PWS750-2U $+V_{IN}$ TO $\pm V_{OUT}$ ISOLATION TRANSFORMER					
ISOLATION					
Voltage Rated Continuous AC 60Hz		750			Vrms
100% Test [1]	60Hz, 1s, <5pC PD	1200			Vrms
Barrier Impedance			10^{12} || 8		Ω || pF
Leakage Current at 60Hz	V_{ISO} = 240Vrms		1	1.5	µArms
Winding Ratio	Primary/Secondary		48/48		
PWS750-3U DIODE BRIDGE					
Reverse Recovery	$I_F = I_R$ = 50mA		40		ns
Reverse Breakdown	I_R = 100µA	55			V
Reverse Current	V_R = 40V			1.5	µA
Forward Voltage	I_F = 100mA			1.6	V
PWS750-4U $+5V_{IN}$ to $\pm 15V_{OUT}$ ISOLATION TRANSFORMER					
ISOLATION					
Voltage Rated Continuous AC 60Hz		750			Vrms
100% Test [1]	60Hz, 1s, <5pC PD	1200			Vrms
Barrier Impedance			10^{12} || 8		Ω || pF
Leakage Current at 60Hz	V_{ISO} = 240Vrms		1	1.5	µArms
Winding Ratio	Primary/Secondary		24/70		
TEMPERATURE RANGE					
Specification		0		+70	°C
Operating	Derated performance	–40		+85	°C
Srorage		–40		+85	°C

NOTES: (1) Tested at 1.6 x rated, fail on 5pC partial discharge leakage current on five successive pulses at 60HZ.

PIN CONFIGURATIONS



ABSOLUTE MAXIMUM RATINGS

Supply Voltage	18V
Junction Temperature	150°C
Storage Temperature	–40°C to +85°C
Lead temperature (soldering, SOIC, 3s)	+260°C
Max Load, Sum of Both Outputs (PWS750-2U, 4U)	60mA

ORDERING INFORMATION

PWS750-XU

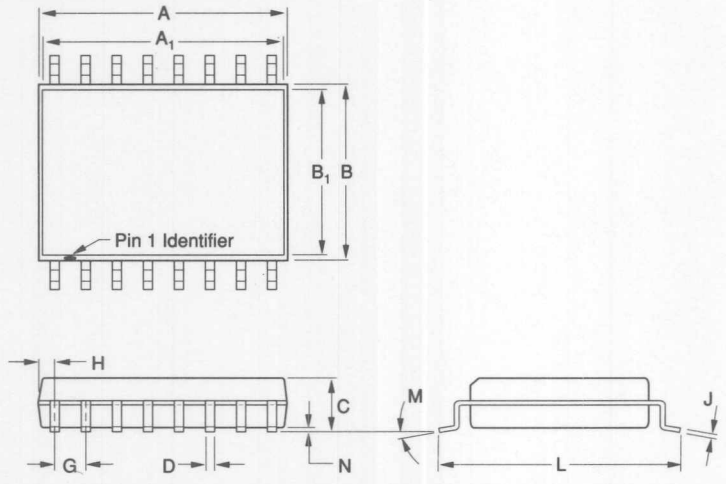
Basic Model Number

Components

1U : High-Frequency Driver
2U, 4U : Isolation Transformer
3U : High-Speed Monolithic Diode Bridge

MECHANICAL (211)

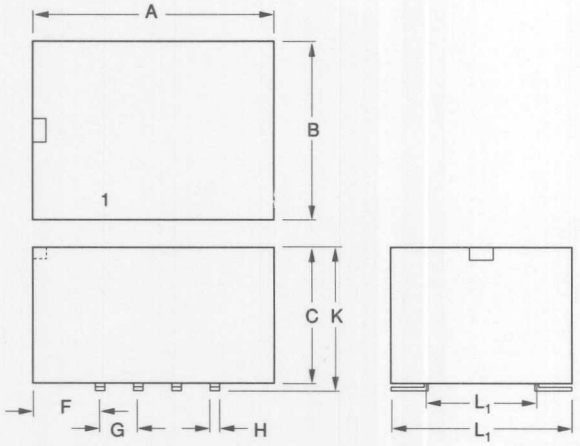
U Package — 16-Pin SOIC



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.400	.416	10.16	10.57
A1	.388	.412	9.86	10.46
B	.286	.302	7.26	7.67
B1	.268	.286	6.81	7.26
C	.093	.109	2.36	2.77
D	.015	.020	0.38	0.51
G	.0.50 BASIC		1.27 BASIC	
H	.022	.038	0.56	0.97
J	.008	.012	0.20	0.30
L	.391	.421	9.93	10.69
M	5° TYP		5° TYP	
N	.000	.012	0.00	0.30

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane.

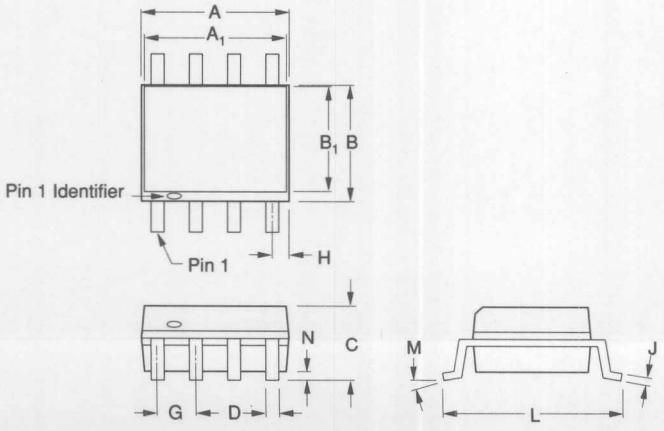
U Package — 8-Pin Plastic DIP



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.620	.640	15.78	16.26
B	.465	.485	11.81	12.32
C	.350	.370	8.89	9.40
F	.165	.185	4.19	4.70
G	.100 BASIC		2.54 BASIC	
H	.025 SQ		.635 SQ	
K	.370	.390	9.40	9.91
L1	.280	.300	7.11	7.62
L2	.465	.485	11.81	12.32

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane. Pin numbers shown for reference only. Numbers may not be marked on package.

U Package — 8-Pin SOIC



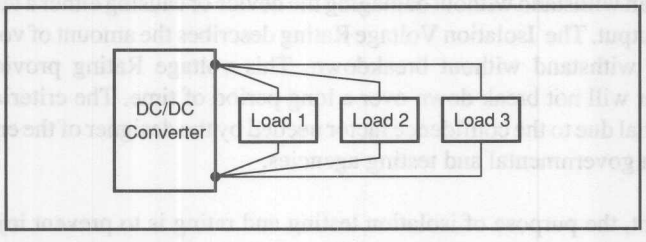
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.185	.201	4.70	5.11
A1	.178	.201	4.52	5.11
B	.146	.162	3.71	4.11
B1	.130	.149	3.30	3.78
C	.054	.145	1.37	3.69
D	.015	.019	0.38	0.48
G	.050 BASIC		1.27 BASIC	
H	.018	.026	0.46	0.66
J	.008	.012	0.20	0.30
L	.220	.252	5.59	6.40
M	0°	10°	0°	10°
N	.000	.012	0.00	0.30

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane.

APPLICATION NOTES

I. OUTPUT POWER DISTRIBUTION

The following figure shows the recommended method of connecting multiple loads to the converter. Single point distribution prevents ground loops and interaction between parallel load circuits.

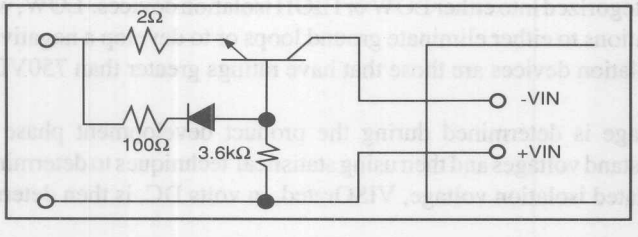


Recommended Power Distribution

II. SHORT CIRCUIT PROTECTION

Unless otherwise stated on the Product Data Sheet, overloads or short circuits on the outputs of Power Convertibles will damage the unit. If the model you are interested in does not have short circuit protection, we recommend a fast-blow fuse on the input to the device. Provided in the figure is an external method of implementing the short circuit protection function. This is a specific example for one model. Because the value of input current varies significantly with input voltage, the values of the resistors will need to be changed depending on the "trip-point" of the input current you set and the Beta of the transistor. You also need to select a transistor with the appropriate current rating for your application.

In this example, the circuit limits the input current to approximately 100mA for an input voltage of 15VDC (Beta of transistor = 50)



Short Circuit Protection

III. UNDERSTANDING ISOLATION WITHSTAND VOLTAGES

DEFINING ISOLATION VOLTAGE AND TESTING REQUIREMENTS

No doubt there is much confusion on the subject of isolation voltage. Engineers must consider: actual voltages that will be seen in the application, "rated" versus "tested" isolation voltages, and what voltages are required to pass any governmental or regulatory agency standards. Unfortunately, due to the many agencies and the classifications within specific industries, it is impossible to detail here all requirements. (The IEC 950 specification alone is almost 250 pages!) Therefore, this application note is limited in scope to how Power Convertibles are specified and tested, within the framework of general agency "standards".

First, some quick definitions (see the Glossary for details). Isolation voltage, sometimes referred to as "dielectric withstand voltage", is the potential (voltage) difference between the input common and the output common terminals that the device can withstand without damaging the device or causing either a temporary or permanent short between input and output. The Isolation Voltage Rating describes the amount of voltage that the isolation barrier can continuously withstand without breakdown. This voltage Rating provides a high degree of confidence that the barrier will not break down over a long period of time. The criteria for isolation voltage Testing or Rating is essential due to the confidence factor needed by the designer of the end-use equipment, and requirements from certain governmental and testing agencies.

From an agency viewpoint, the purpose of isolation testing and rating is to prevent injury or damage due to electrical shock, heat or fire. The safety aspects vary from industry to industry and even within an industry. Isolation is used to prevent electrical shock by separating the primary and secondary circuits through the use of transformers, insulation, and space.

"RATED" VERSUS "TEST" ISOLATION VOLTAGES

One of the important considerations when discussing isolation voltage is the difference between "Rated" and "Test". The Rated is the isolation voltage that the device is designed and manufactured to withstand in a continuous operating environment. The Rated voltage is established by the design of the product, the materials used in construction, and the spacing of the internal and external components. A "Test" voltage has become the generally accepted way to verify that a device will continuously operate safely. This Test voltage is a convenient method of assuring conformance to the Rated voltage, as it is obviously impractical to "life-test" each production unit. This Test voltage, for high isolation requirements, is often a stress test to ensure the devices will in fact operate under Rated voltage conditions. The magnitude of the Test voltage is, however, not derived by a universally accepted standard. The net result is that the system designer must know the application requirements AND the agency requirements.

ISOLATION VOLTAGE RATINGS

Power Convertibles are categorized into either LOW or HIGH isolation devices. LOW, which are typically used in general purpose applications to either eliminate ground loops or to develop a negative voltage, have ratings up to 750VDC. HIGH isolation devices are those that have ratings greater than 750VDC.

The Rated isolation voltage is determined during the product development phase by taking devices to destruction with high withstand voltages and then using statistical techniques to determine a minimum isolation voltage, VISOmin. The Rated isolation voltage, VISOrated, in volts DC, is then determined by the formula:

VISOrated = (VISOmin - 1000)/2

This formula or general rule conforms to many maximum agency specifications and therefore is considered to be a conservative approach. All Power Convertibles, both LOW and HIGH isolation devices, are designed in this manner. However, the Test Voltage is different for the two types. For HIGH isolation devices, Test Voltage is generally greater than two times the Rated Voltage, plus 1,000 Volts, for 60 seconds. An example of this would be for a part Rated at 1,000 Volts -- the Test voltages would be 3,000 Volts, i.e., (2 x 1,000) + 1,000 = 3,000. For LOW isolation devices, the Test Voltage is equal to the Rated Voltage, for 10 seconds.

The Test voltage is essentially sinusoidal and is measured with units of Vpk. Agencies will typically have requirements stated in Vrms, so one can simply multiply by 0.707 to obtain the Vrms. Please note that unlike power considerations, when trying to understand the withstand voltage, the key is the "instantaneous absolute potential". Thus for rating purposes, when using a Power Convertible, the same actual voltage may be applied continuously, whether it is an VAC-pk or VDC. In other words, if a specification states "750VDC", it can be operated safely at 750VDC or 750VAC-pk, but this is not the same as 750Vrms.

One additional item to consider is that a few suppliers only show the Test voltage on their specification. In fact, many do not describe whether the specified "Isolation Voltage" is Rated or Tested. This is ambiguous and leaves it up to the customer to discover what the real isolation voltage rating is and where the device can be safely applied. It should also be noted that some Power Convertibles do not conform to the Test voltage general rule (Vtest = 2 x Vrated + 1000V) due to specialized applications where the Test voltage requirements are very high. Where system voltages can be well defined or where the isolation voltage is not continuous, the system designer may choose a less conservative approach in setting the Rated voltage from the given Test voltage specification.

RETESTING OF ISOLATION VOLTAGE

Considering the fact that isolation voltage testing for HIGH isolation devices is a stress test, it is undesirable to retest the barrier, as the re-test itself, may induce failures. Although select parts have been designed for some retesting due to known industry requirements, most other DC/DC converters, besides these select Power Convertibles, are not designed for multiple testing. Dielectric withstand testing is intended to be done only at the manufacturer's site. This test should not be repeated. Exposing the dielectric material of the isolation barrier to repeated testing causes microscopic carbonizing of the dielectric, resulting in a weakened barrier. A low resistance path will eventually be created across the barrier.

PRESERVING ISOLATION CHARACTERISTICS

If intrinsic safety is required, care should be taken in the layout of the assembly or Printed Circuit Board (PCB) to avoid degrading the isolation barrier of the Power Convertible. Precautionary measures include cleaning the PCB prior to installing the DC/DC converter. Many products include stand-offs built into the packaging to ease the cleaning procedure after installation. Should the DC/DC converter not have built-in stand-offs, use non-conductive spacers. Clean regularly to insure no contaminates accumulate under the unit. Use an epoxy solder mask to isolate PCB conductive traces that must run under or close to the converter. Do not use conductive inks in the PCB under the unit, e.g., inks used in inspection stamps or component identification marking.

LEAKAGE TESTING

Leakage current for AC/DC power supplies is typically measured through a resistor connected to earth ground. DC/DC Power Convertibles, since they are not connected to line voltages, are measured to find the leakage current from primary to secondary, by applying a 240VAC across input to output. Power Convertible leakage currents are typically measured in the microAmpere range. Since a system must be typically less than 5mA for portable equipment and 3.5mA for office and data processing equipment, the system engineers can take advantage of low leakage Power Convertibles. In addition, this high isolation/low leakage current allows one to "disconnect" grounds and the Power Convertible can be used to help reduce noise in sensitive applications.

SPACING REQUIREMENTS

Some agencies mandate certain space requirements between components. The specific differences are determined by the amount of voltage that is present. The agencies vary dramatically in this area, and one must be very careful to analyze not only the selection of the power conversion unit, but even the thickness of a circuit board.

Power Convertibles have an advanced encapsulant, called Iso-ThermoFlex™ that is superior not only in its heat dissipation, but in its electrical insulation properties and flexibility/elasticity. These characteristics aid in the isolation voltage withstand and are much better than open, unencapsulated units that rely on "free-air" conditions.

SAFETY AGENCIES & STANDARDS

The international safety agencies are getting much closer in their standards. For power devices, it appears the main standard in the future will be based on the IEC 950. The U.S. and Canadian standards are similar and differences within Europe can be attributed to the lack of a three-wire grounded electrical source throughout Europe. Additionally, the standards are continuously being upgraded and changed, e.g., IEC 950 reduced separation and dielectric withstand requirements from previous regulations of IEC 435 and IEC 380.

There are many safety agencies throughout the world, and sometimes it is difficult to even figure out what agency will be involved and what will be the appropriate standard that the agency will require the end-use equipment to meet. Please note that standards are subject to revision and one must always check with the appropriate agency before designing a product.

The following are an alphabetical listing of the agencies, their respective geographical areas, and some of the relevant standards:

BABT/BSI - United Kingdom
BSI6301 — Connection to British telecom networks

CENELEC — Committee for European Electrotechnical Standardization,
this sets the standards for ISO (International Standards Organization)

CSA - Canadian Standards Association

The primary standards are CSA 22.2 No. 234 — Safety of Component Power Supply, and CSA C22.2 No. 220 — Information Processing and Business Equipment, (Note: Testing ends in September 1993, all product should be submitted to CSA 22.2 No. 950, thereafter.) Some of the specs that are important to consider are as follows:

RELATED CANADIAN STANDARDS

CSA 22.2 No. 0.4 — Bonding and Grounding
CSA 22.2 No. 0.7 — Equipment Electrically CONNECTED to a Telecommunications Network
CSA 22.2 No. 66 — Specialty Transformers
CSA 22.2 No. 125 — Medical and Dental Equipment
CSA 22.2 No. 143 — Office Equipment
CSA 22.2 No. 154 — Data Processing Equipment (Note: phased out in September of 1988)
CSA 22.2 No. 950 — Same as IEC 950
CSA Z237.1 — Definition of Electrical Terms

IEC - International Electrotechnical Commission (See VDE for any standards)

MHW - Japan
JIS T1001-1003,4 — Laboratory and Medical Equipment

THE NORDIC COUNTRIES
All of the Nordic countries use IEC950/EN60950, but each has clarifications in document EMKO-TUE-(74-SEC) 203/90.

DEMKO - Denmark
NEMKO - Norway
SEMKO - Sweden
SETI - Finland

UL - Underwriters Laboratories (United States)

The primary Standards are as follows:
UL 478 — Electronic Data Processing Units and Systems (NOTE: Testing ends in March 1992, all product should be submitted to UL 1950, thereafter.)
UL 508 — Industrial Control Equipment

OTHER RELATED STANDARDS
UL 73 — Electric Motor-operated Appliances
UL 94 — Flammability of Plastic Materials
UL-144 — Office Equipment
UL 507 — Electric Fans
UL-478 — Data Processing
UL 544 — Medical and Dental Equipment
UL 1012 — Power Supplies
UL 1244 — Measurement and Test Equipment
UL 1262 — Laboratory Equipment
UL 1310 — Direct Plug-in Power Supplies and Transformers
UL 1459 — Telephone Equipment
UL 1950 — Same as IEC 950, with some minor differences

VDE or TÜV - Germany

IEC 950 is becoming the over-riding document that most agencies are using as the basic reference. Test voltages are prescribed in a detailed table contained within the specification, and is dependent upon the "working" voltage.

RELATED STANDARDS
IEC 380/VDE 0806 — Office Machines (Note: Obsolete, See IEC 950/EN 60950.)
IEC 601/VDE 0750 — Medical and Dental Equipment

REFERENCES

High-Frequency Switching Power Supplies, George Chryssis, Copyright 1984 by McGraw-Hill, Inc.
A Primer on International Regulatory Standards, Powertechnics Magazine, November 1989
Gaining Safety Agency Approvals, Powertechnics Magazine, March 1989

IV. MULTIOUTPUT / MULTICHANNEL CONFIGURATIONS

Parallel and Series Operation - Power Calculations - Polarity Considerations

If not otherwise stated on the Product Data Sheet, paralleling the outputs to increase available current is not recommended. Unless models are specifically designed to share current, one device will tend to supply more than 50% of the current and eventually, as the load is increased, will be operating over its rated power.

For clarification, here are a few definitions:

Single Output - one output voltage. In an isolated device this can be either positive or negative depending on how the user configures the grounding.

Dual Output - two output voltages of the same magnitude, one being positive the other being negative, referenced to the same ground.

Triple Output - three output voltages. The most common example being +5VDC, and ±12VDC.

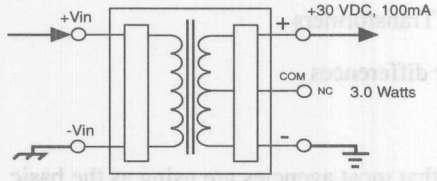
Single Channel - all outputs are referenced to the same grounding point.

Dual Channel - two isolated output sections. Each section (or channel) can have multiple outputs.

Series operation of isolated outputs is permissible. Because the isolation provides fully "floating" outputs, each CHANNEL may be referenced according to the needs of the application. The flexibility in multichannel Power Convertibles is considerable allowing the designer to provide unusual voltages. When designing with Power Convertibles in series, a frequent mistake is to miscalculate power. Although it seems simple, when dealing with multichannel and multioutput devices the necessity to multiply or divide by 2 is often overlooked. It is wise to check that the total expected power is not more than the sum of the power ratings of the devices used.

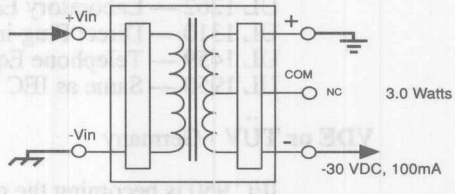
In the following examples, each OUTPUT is 15VDC and rated at 100mA. (NC = No Connection).

A



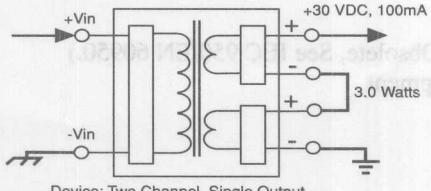
Device: One Channel, Dual Output
Configuration: One Positive Vout

B



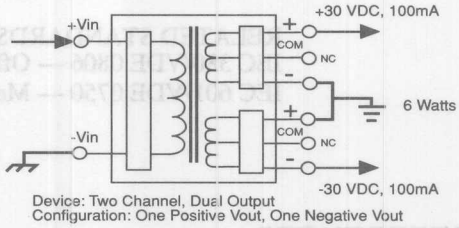
Device: One Channel, Dual Output
Configuration: One Negative Vout

C



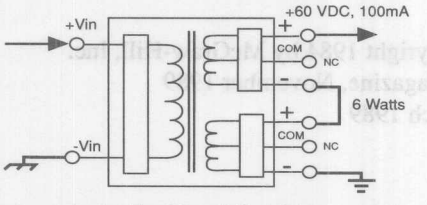
Device: Two Channel, Single Output
Configuration: One Positive Vout

D



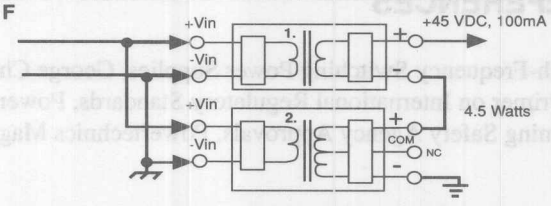
Device: Two Channel, Dual Output
Configuration: One Positive Vout, One Negative Vout

E



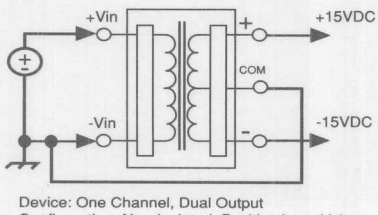
Device: Two Channel, Dual Output
Configuration: One Positive Vout

F



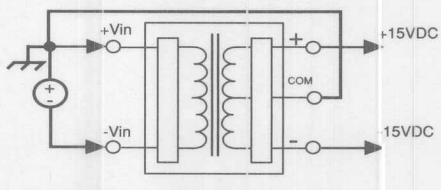
Two Devices: 1. One Channel, Single Output
2. One Channel, Dual Output
Configuration: One Positive Vout

G



Device: One Channel, Dual Output
Configuration: Non-Isolated, Positive Input Voltage
(Isolation possible by removing common connection)

H



Device: One Channel, Dual Output
Configuration: Non Isolated, Negative Input
(Isolation possible by removing common connection)

V. CAPACITIVE LOADING EFFECTS ON START UP OF DC/DC CONVERTERS

Output capacitors draw charging current during the start-up phase of switching power supplies. The magnitude of this current should be taken into account when selecting both the output capacitance value and the DC/DC converter power rating. In most cases, this charging current is of little significance to the output current rating of the DC/DC, especially if the steady state application uses less than the FULL rated power of the device.

However, when dealing with low-power DC/DC's, this capacitive charging current may become significant. If it is too high, it could send the DC/DC into a current limiting mode (a form of overload protection), from which a power down may be necessary to restart. Power supplies in current limit mode show an abnormally low output voltage. Since the unit never really came up to proper output in the first place, it could appear to be a faulty unit, when in actuality it is performing properly.

This start-up issue is much more likely to occur with "self-oscillating" type designs inside the DC/DC converter rather than fixed frequency driven designs. The advantages of self-oscillating designs are the lower component counts and therefore low costs. Self-oscillating topologies are most often used for DC/DC converters of less than 3 watts.

The basic equation that describes the charging current draw of the output capacitance is:

$$i(cap) = C \frac{\Delta V}{\Delta t} \quad \text{where:}$$

$i(cap)$ = capacitance charging current (amps)
C = output capacitance (farads)
ΔV = change in output voltage (volts DC)
Δt = rise time on input pins (seconds)

The **input** rise time is used for a worst case analysis because this is the speed with which the DC/DC is trying to charge the capacitor.

Consider a 10µF capacitor filtering an output voltage of 5.0VDC with an input voltage rise time of 10µSec. Therefore, the capacitor tries to draw 5.0 Amps to charge itself in this short time.

As another example, consider two 10µF capacitors, one on each output of a ±15VDC DC/DC converter. The rise time of 10mSec would yield a current draw of 15mA.

Once the start-up charging current is calculated the next step is to evaluate if this is an acceptable level. You must add this current demand to the steady state current demand of the load.

$i(total) = i(cap) + i(ss)$ where:

$i(ss)$ = steady state current load

Only if the total current exceeds the rated current is there cause for concern. In some cases, as in the 750mW HPR1XX Series, there is an additional current available for this start-up transient (see Product Data Sheet).

Remember also that most DC/DC converters have internal filter capacitors in the output section. Although these are typically unspecified in product literature, they will become critical if the input voltage rise time approaches zero (a true "hard start"). This internal output capacitance is not taken into account in the above equations since this equation is a linear approximation or first-order type of analysis.

If a problem does exist, there are two potential remedies. First, minimize the output capacitance. Sometimes "standard" values of decoupling capacitors are used without any real evaluation for the filtering requirements necessary. Second, attempt to slow the rise time at the pins of the DC/DC converter. Depending on the source impedance of input supply voltage, this might be accomplished by adding an input capacitor.

VI. LOW NOISE CONSIDERATIONS

Large ground planes are recommended because they serve as low inductance reference points for all components and increase the effectiveness of the shielding inside the DC/DC converter. The shield is usually attached to input common. If this input common is not a "quiet" reference, the shield, with its large physical area, could become a potential source of noise distortion.

RECOMMENDED NOISE MEASUREMENT

The inherent switching inside the DC-to-DC converter gives rise to potential sources of noise. This noise manifests itself on the output voltage as spikes at the switching frequency. Due to size and cost requirements, internal filtering is limited, but usually adequate for most applications. When excessive noise is suspected, you must first rule out extraneous noise sources. Figure 1 illustrates the recommended method for testing output voltage ripple and noise.

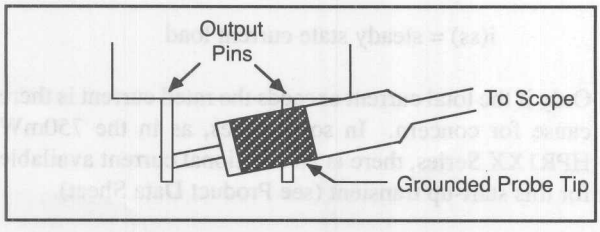


FIGURE 1. Recommended Noise Measurement Method

If your circuit requires less noise than the supply is capable of, there are two preferred filter techniques—LC filters or an output filter capacitor.

CHOOSING AN OUTPUT CAPACITOR

The saying "the more the better" is definitely not applicable to output capacitors of switching type power supplies. The basic design equations of the supply rules out any brute force approach. The parameter of major concern is the Effective Series Resistance (ESR). ESR is due to stray resistance inside the electrolytic capacitor that becomes significant at switching power supply frequencies and higher. Together with Effective Series Inductance (ESL), ESR can be modeled as the equivalent circuit shown in Figure 2.

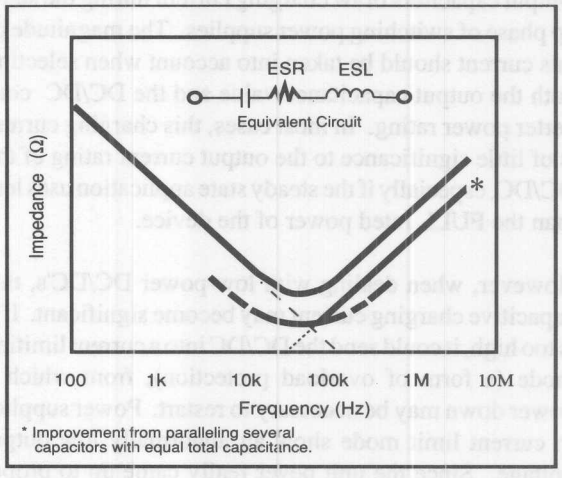


FIGURE 2. Typical Log/Log Impedance Plot for Aluminum Electrolytic Capacitor.

ESR is also a function of temperature and actually decreases as temperature is increased. This temperature dependency is particularly strong in the below zero range as shown in Figure 3. This, together with decreasing capacitance (Figure 4), can prove fatal to a switcher design that performed well on the bench.

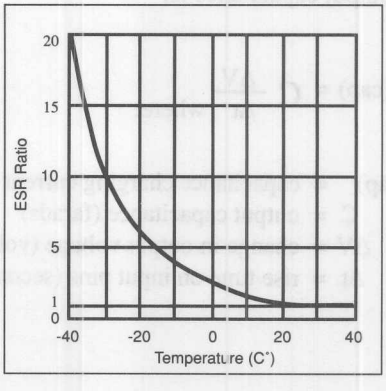


FIGURE 3. ESR Ratio Relative to Room Temperature

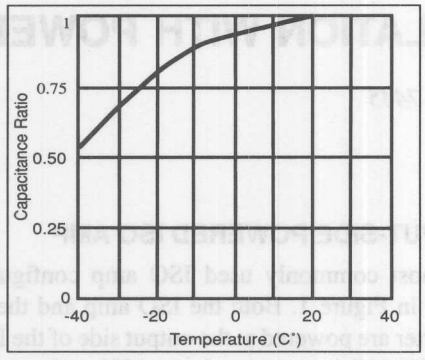


FIGURE 4. Capacitive Ratio Relative to Room Temperature

The ESR becomes, in effect, a voltage divider with the internal output resistance of the supply. Therefore, the lower the ESR, the better suited the capacitor is for filtering the output of a switching type power supply. As the load increases, the capacitors' ripple current increases, causing a larger drop across the ESR, and consequently, a larger output ripple voltage (seen as noise). A commonly used method for estimating ESR is by means of the equation:

$$ESR=DF \times 0.01/2\pi fC$$

Where DF is given in %, f is given in Hertz, and C is given in farads. Dissipation factor (DF) is a function of frequency and is useless if given at less than 1kHz. (If given at lower frequencies, it is more indicative of equivalent parallel resistance). If given at 1kHz or greater, the above equation applies. Typical values are 8% to 24% at 1kHz for solid tantalums, and 0.1% to 3% at 1kHz for ceramics, and 8% at 120Hz for aluminum electrolytics. Most tantalum and aluminum electrolytic capacitor manufacturers do not specify the ESR, probably because it is not worth bragging about. One way of reducing ESR in design is to put two or more capacitors in parallel that add to the needed capacitance and reduce the ESR by the parallel resistance relation (see note in Figure 2). The second capacitor may be 1/10 or 1/100 the capacitance of the first, since it will provide bypassing for higher frequencies.

There are two basic families of electrolytic capacitors from which to choose: aluminum and tantalum. Aluminum types are available in many quality grades and fabrication techniques. Tantalum types come in foil, solid, and wet-slug subtypes. At first this may present a bewildering array of choices, but these can quickly be reduced by your particular need. Cheap aluminum electrolytics of questionable quality are often used, but all too frequently this leads to actual noise generation, with poor reliability and in general, criticisms of high frequency switching type supplies. Good quality aluminum electrolytics probably provide the best compromise, if one must be made, between cost and performance. These are "computer grade" and other types made especially for switchers. Some have specialized construction that produce very low ESR and ESL rather than low cost. The outstanding feature of all tantalum types is their high capacitance to volume efficiency. This is particularly seen in the wet-slug tantalum, an undisputed winner in the capacitance versus volume contest. Solid tantalums appeal where there is a great emphasis on longevity, both shelf life and operating life. The foil-type tantalum is a very good capacitor for switchers, but is not cost competitive with aluminum types. Where switching frequencies are very high (1MHz and greater) and current demands are low, nonelectrolytic capacitors will probably replace the previously discussed electrolytics, providing bypassing at high frequencies where the ESL of electrolytics becomes too high.

In addition to considering the capacitance, ESR, ESL, and appropriate voltage derating for the application, most capacitors have a maximum rms ripple current (or max rms ripple voltage) rating which should not be exceeded. Ripple current can be estimated by $i_{rms} = i_{p-p}/3.5$ (or $V_{rms} = V_{p-p}/3.0$). These ratings are too often ignored, but the stress produced by exceeded ripple will adversely effect the lifespan of the output filter capacitor.

The effect of ripple current flowing in the output capacitor is the dissipation of heat in the capacitor's ESR. Heat kills electrolytics in two ways -- electrolytic depletion and electrolytic evaporation. The rate at which the electrolyte is lost depends on the electrolyte itself and the capacitor's internal structure. But whatever that rate, tests by aluminum capacitor makers indicate it nearly doubles for each 10°C rise in temperature. Thus, each 10°C rise cuts the usable life of an aluminum capacitor in half. The best approach to counter this problem is to use capacitors designed and rated for higher temperatures.

Whatever capacitor is selected, its effective use depends greatly upon wiring techniques. For example, inductance can become dominant if good wiring practices are not followed and a low ESL requirement can be reduced through very careful wiring. Place the capacitor as close as possible to the load rather than the power supply. The reason for this is the presence of inductance in the wire or PCB trace and the existing output capacitor inside the supply. A small pi filter is formed furthering the reduction of noise. Capacitor lead length including circuit wiring on both sides of the capacitor should be minimized. Short, wide straps are the best and these can be paralleled for further reduction in self-inductance.

It's true that good capacitors have played a big role in making switching type power supplies a technological and commercial success, but this success has inspired the capacitor makers to devise even better suited types. Because of this impetus and the versatility of the switching power supply, it is difficult to say that one type of capacitor is inherently better than another. Most capacitor manufacturers are willing and able to provide advice that would help you in your decision.

VERY LOW COST ANALOG ISOLATION WITH POWER

By Mark Stitt (602) 746-7445

You can make a low-cost, precision analog isolation amplifier (ISO amp) with power by combining the ISO122 low-cost ISO amp with the HPR117 low-cost DC/DC converter. With isolated signal and isolated power in separate packages, complete application flexibility is assured.

The ISO122 features:

- Unity gain (±10V In to ±10V Out): ±0.05%
- 0.02% max nonlinearity
- 5mA quiescent current
- 140dB isolation mode rejection at 60Hz
- 1500Vrms continuous isolation rating (100% tested)

The HPR117 features:

- $V_{OUT} = V_{IN}$, ±5% (V_{IN} = 13.5V to 16.5V, I_{OUT} = 25mA)
- I_{OUT} = 25mA (750mW) continuous at 85°C
- 8mA quiescent current, no load
- 80% efficiency, full load
- Low output ripple
- 750VDC isolation rating

OUTPUT-SIDE POWERED ISO AMP

The most commonly used ISO amp configuration is shown in Figure 1. Both the ISO amp and the DC/DC converter are powered at the output side of the ISO amp. The HPR117 is connected to +15V and ground. The ISO122 is connected to ±15V and ground. The power-supply connections for the input side of the ISO amp are connected directly to the HPR117 output. No bypass capacitors are needed. The HPR117 has built-in 0.33µF bypass capacitors on both the input and outputs.

The isolated ±15V power output from the HPR117 can also be used for ancillary input-side circuitry such as input amplifiers and references. The ISO122 input section consumes about ±5mA. An additional ±20mA is available for other circuitry.

INPUT-SIDE POWERED ISO AMP

Some applications call for output-side isolation as shown in Figure 2. Isolated ±15V, 20mA auxiliary power is available on the output side for ancillary circuitry.

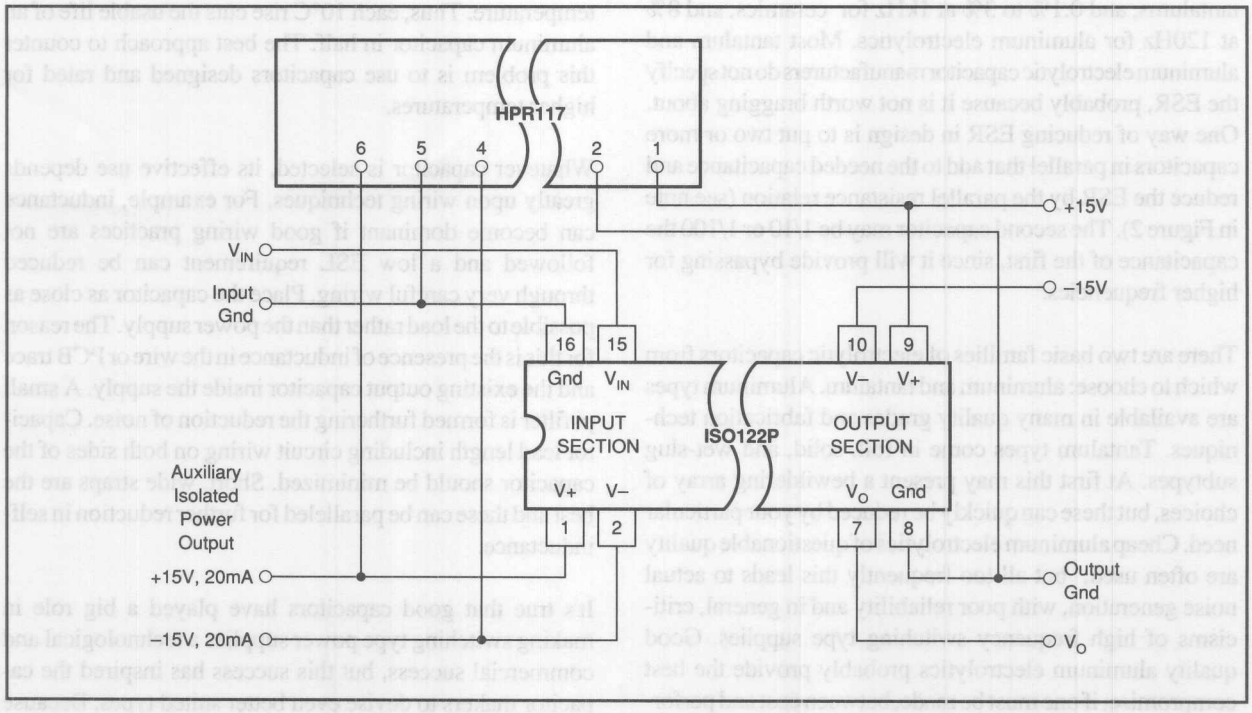


FIGURE 1. Output-Side Powered ISO Amp.

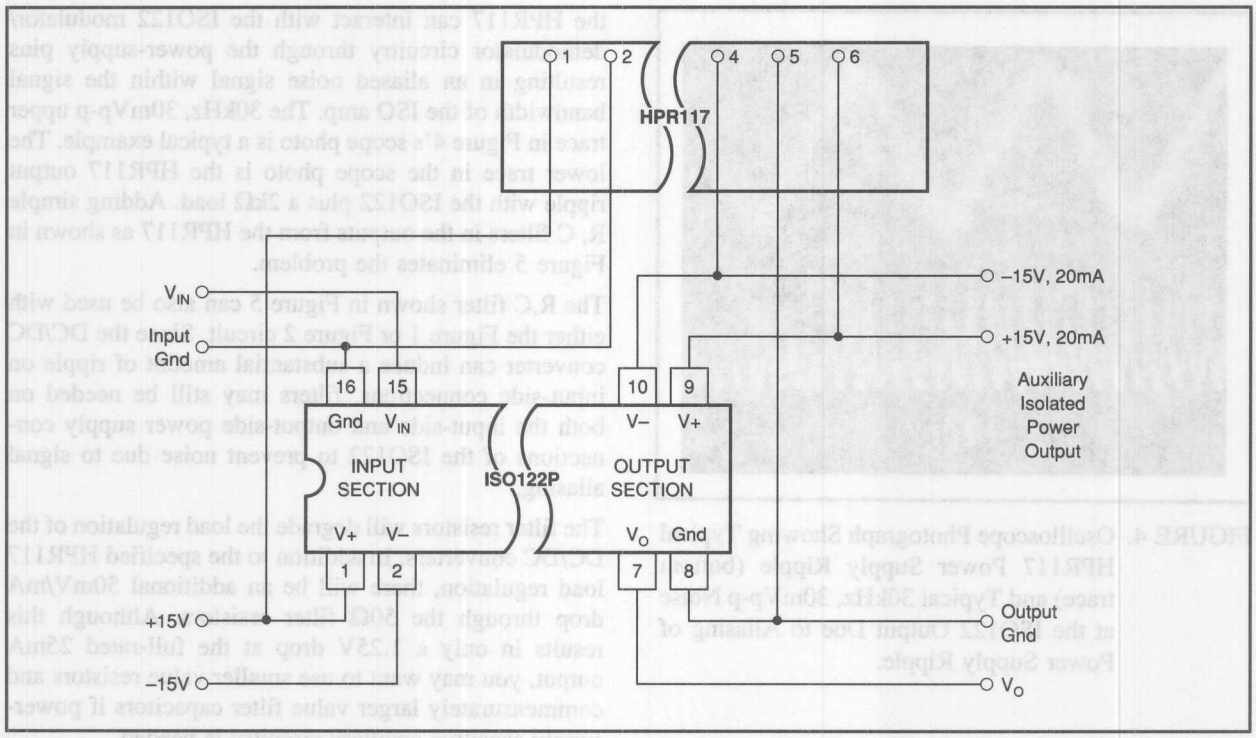


FIGURE 2. Input-Side Powered ISO Amp.

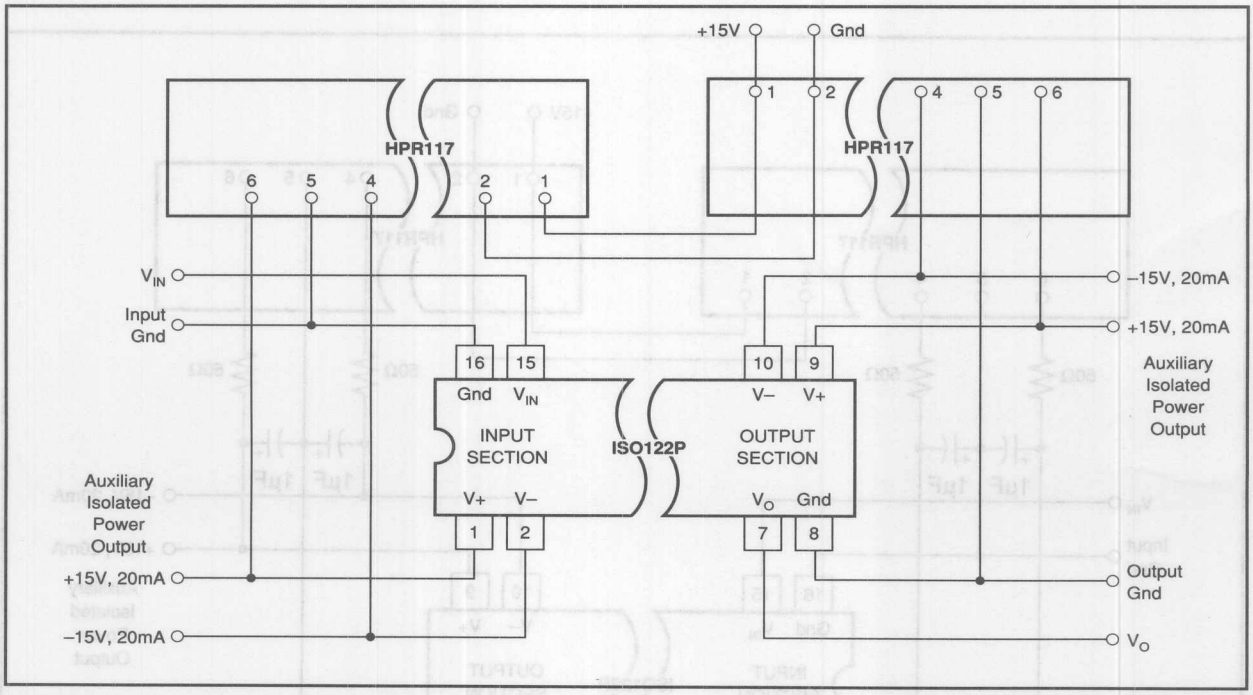


FIGURE 3. Powered ISO Amp with Three-Port Isolation.

THREE PORT ISO AMP

Some applications call for three-port isolation as shown in Figure 3. Both the input and output side of the ISO amp are isolated from the power-supply connection. Isolated ±15V, 20mA auxiliary power is available on both the input and output side of the ISO amp.

ADD RC FILTER TO POWER SUPPLY OUTPUT FOR LOW NOISE

Although performance is good using the ISO122 connected directly to the HPR117, best performance can be achieved with additional filtering. The output ripple of

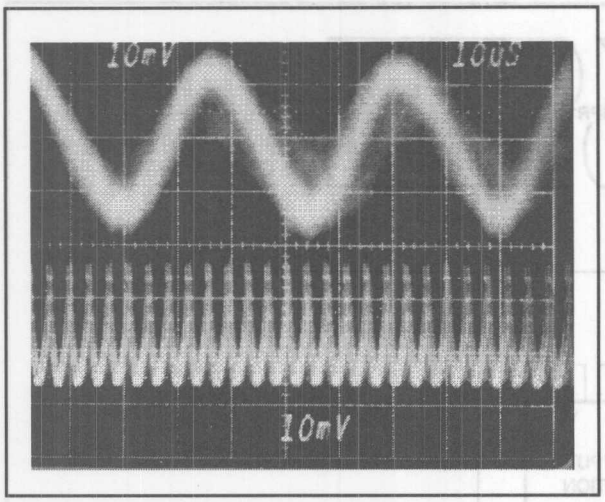


FIGURE 4. Oscilloscope Photograph Showing Typical HPR117 Power Supply Ripple (bottom trace) and Typical 30kHz, 30mVp-p Noise at the ISO122 Output Due to Aliasing of Power Supply Ripple.

the HPR117 can interact with the ISO122 modulator/demodulator circuitry through the power-supply pins resulting in an aliased noise signal within the signal bandwidth of the ISO amp. The 30kHz, 30mVp-p upper trace in Figure 4's scope photo is a typical example. The lower trace in the scope photo is the HPR117 output ripple with the ISO122 plus a 2kΩ load. Adding simple R, C filters in the outputs from the HPR117 as shown in Figure 5 eliminates the problem.

The R,C filter shown in Figure 5 can also be used with either the Figure 1 or Figure 2 circuit. Since the DC/DC converter can induce a substantial amount of ripple on input-side connections, filters may still be needed on both the input-side and output-side power supply connections of the ISO122 to prevent noise due to signal aliasing.

The filter resistors will degrade the load regulation of the DC/DC converters. In addition to the specified HPR117 load regulation, there will be an additional 50mV/mA drop through the 50Ω filter resistors. Although this results in only a 1.25V drop at the full-rated 25mA output, you may want to use smaller value resistors and commensurately larger value filter capacitors if power-supply sensitive ancillary circuitry is needed.

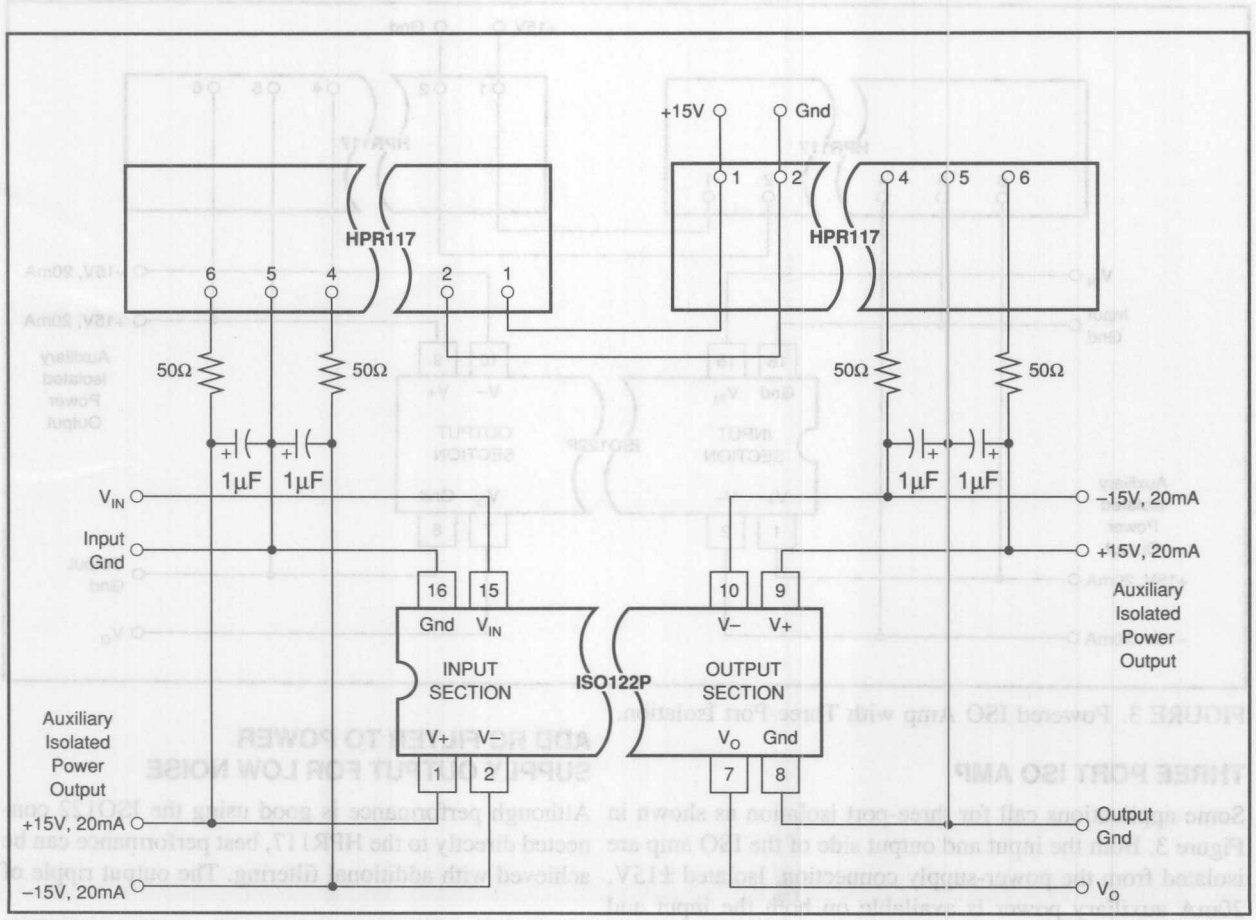


FIGURE 5. Three-Port Isolation Amplifier with R, C Power Supply Filters (eliminates power-supply induced noise).

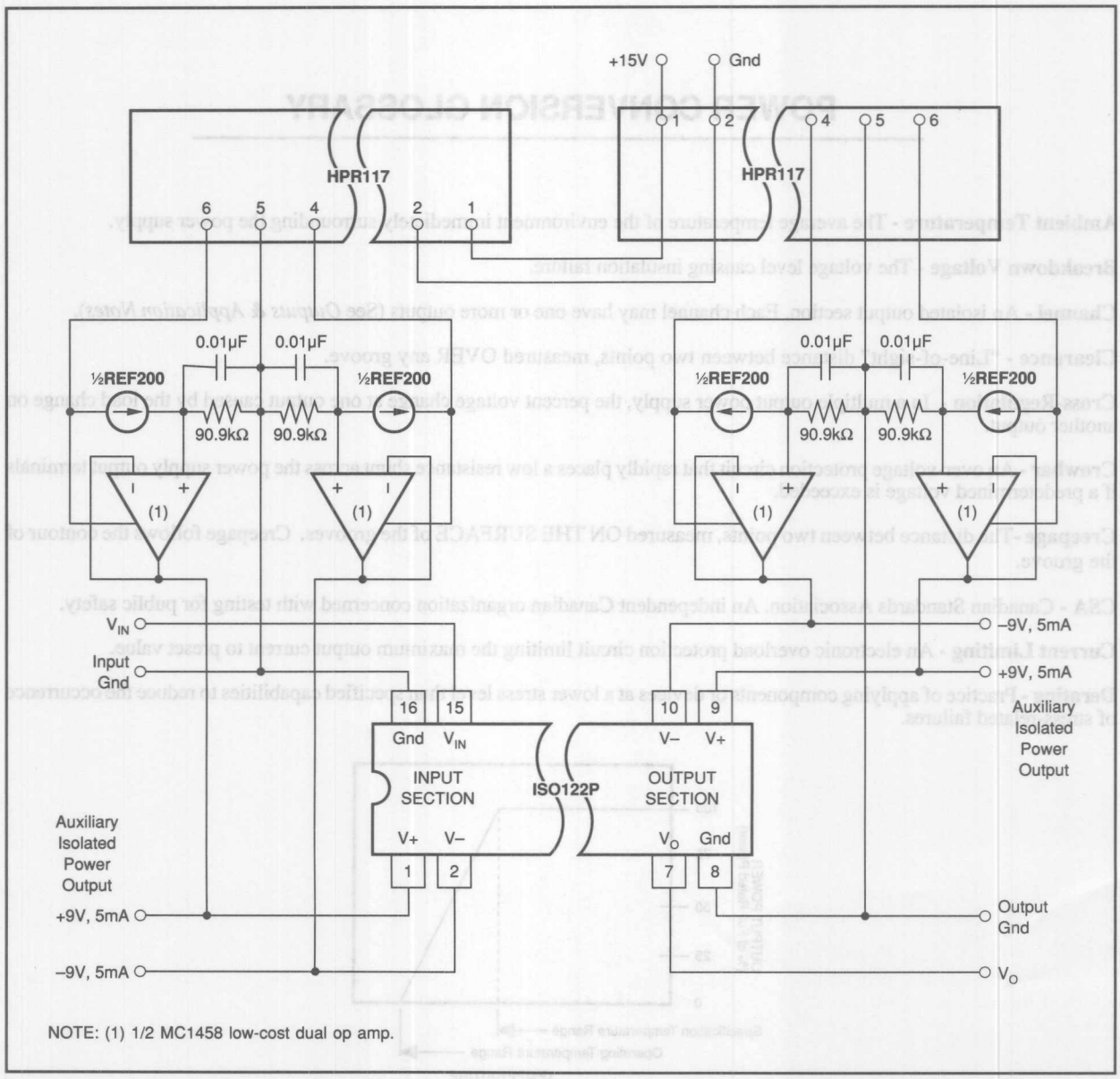


FIGURE 6. Power Supply Regulation in Three-Port Isolation Amplifier (eliminates power-supply induced noise and improves power-supply rejection).

ADD REGULATION FOR IMPROVED POWER-SUPPLY REJECTION

Output ripple can be eliminated and power-supply rejection of the three-port isolation amplifier can be improved as shown in Figure 6. The circuit consists of a dual 100µA current source (the REF200) driving 90.9kΩ resistors to set-up a ±9.09V reference. An inexpensive dual op amp (e.g. Motorola MC1458) is connected as a unity-gain follower to buffer the reference and drive the ISO122. With this circuit, the power-supply rejection is improved from a typical 2mV/V to less than ±1mV for a full 14V to 16.5V input change—(0.4mV/V).

When using the Figure 6 circuit, ISO amp output swing will be reduced. The ISO122 output swing is ±12.5V typ, ±10V min on ±15V supplies. With the ±9V regulated supplies, output swing will be ±6.5V typ, ±4V min.

POWER CONVERSION GLOSSARY

Ambient Temperature - The average temperature of the environment immediately surrounding the power supply.

Breakdown Voltage - The voltage level causing insulation failure.

Channel - An isolated output section. Each channel may have one or more outputs (See *Outputs & Application Notes*).

Clearance - "Line-of-sight" distance between two points, measured OVER any groove.

Cross-Regulation - In a multiple output power supply, the percent voltage change at one output caused by the load change on another output.

Crowbar - An over-voltage protection circuit that rapidly places a low resistance shunt across the power supply output terminals if a predetermined voltage is exceeded.

Creepage -The distance between two points, measured ON THE SURFACE of the grooves. Creepage follows the contour of the groove.

CSA - Canadian Standards Association. An independent Canadian organization concerned with testing for public safety.

Current Limiting - An electronic overload protection circuit limiting the maximum output current to preset value.

Derating - Practice of applying components or devices at a lower stress level than specified capabilities to reduce the occurrence of stress-related failures.

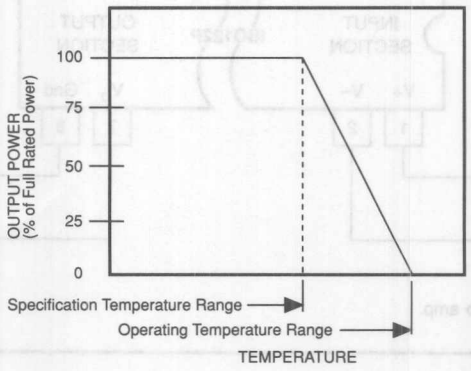


Figure 1. Derating Curve

Dielectric - An insulating material between conductors.

Dielectric Withstand Voltage - The voltage an insulating material will withstand before flashover or puncture. See also *Hi-Pot Test, Isolation.*

Drift - A change in output over a period of time independent of input, environment, or load.

Efficiency - The ratio of the total output power to the total input power, expressed as a percentage, typically given under the specified conditions of nominal input, +25°C, Rated load.

Electromagnetic Interference (EMI) - Any electronic disturbance that interrupts, obstructs, or otherwise impairs the performance of electronic equipment.

EMI - Abbreviation for Electromagnetic Interference.

ESL - Abbreviation for Equivalent Series Inductance.

ESR - Abbreviation for Equivalent Series Resistance.

Equivalent Series Inductance (ESL) - The amount of inductance in series with an ideal capacitor that exactly duplicates the performance of a real capacitor.

Equivalent Series Resistance (ESR) - The amount of resistance in series with an ideal capacitor that exactly duplicates the performance of a real capacitor.

Faraday Shield - An electrostatic shield between input and output windings of a transformer. This can be used to reduce coupling capacitance.

Flyback Converter - A power supply switching circuit that normally uses a single transistor. During the first half of the switching cycle, the transistor is on and energy is stored in a transformer primary. During the second half of the switching cycle, this energy is transferred to the transformer secondary and the load.

Foldback Current Limiting - A power supply output protection circuit whereby the output current decreases with increasing overload, reaching a minimum at short circuit. This minimizes internal power dissipation under overload conditions. Foldback current limiting is normally used with linear regulators.

Forward Converter - A power supply switching circuit that transfers energy to the transformer secondary when the switching transistor is on.

Ground Loop - A condition causing undesirable voltage levels when two or more circuits share a common electrical return or ground lines.

Hi-Pot Test (High Potential Test) - A test performed by applying a high voltage for a specified time to two isolated points in a device to determine adequacy of insulating materials.

Input Line Filter - A low-pass or band-reject filter at the input of a power supply that reduces line noise fed to the supply.

Input PI Filter - See *PI Filter*.

Input Voltage Range - The range of input voltage values for which a power supply or device operates within specified limits.

Inverter - A device that changes DC power to AC power.

Isolation Capacitance - The capacitance across the isolation barrier.

Isolation Resistance - The resistance across the isolation barrier.

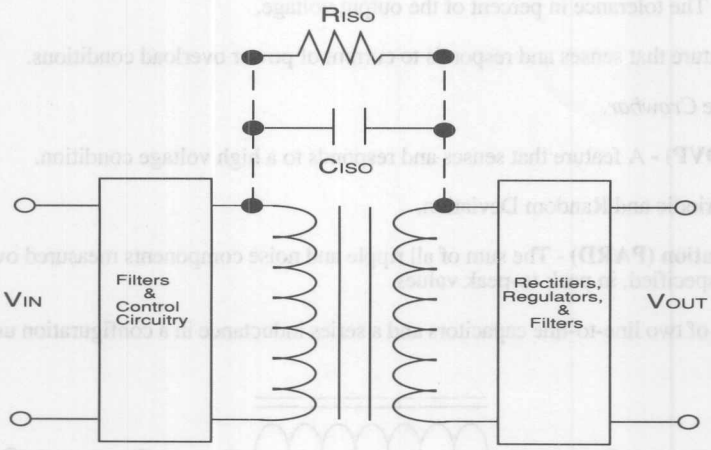


FIGURE 2. Isolation Resistance and Capacitance

Isolation - The electrical separation between two circuits, or circuit elements.

Isolation Voltage - The maximum AC or DC specified voltage that may be continuously applied between isolated circuits.

Leakage Current - The AC or DC current flowing from input to output and/or chassis of an isolated device at a specified voltage.

Line Regulation - The percentage change in output due to the input voltage varying over its specified limits, at specified load values, with all other factors constant.

Linear Regulation - A regulation technique wherein the control device, such as a transistor, is placed in series or parallel with the load.

Load Decoupling - The practice of placing filter components at the load to attenuate noise.

Load Regulation - 1) Static: The change in output voltage as the load is changed from specified minimum load to maximum and maximum to minimum, with all other factors held constant.
2) Dynamic: The change in output voltage expressed as a percent for a given step change in load current. Initial and final current value and the rates of change must be specified.

Logic Inhibit/Enable - A referenced or isolated logic signal that turns a power supply output off or on.

MTBF - Abbreviation for Mean Time Between Failure.

MTTF - Abbreviation for Mean Time To Failure.

Mean Time Between Failure - The average length of time between system failures, exclusive of infant mortality and rated end-of-life. An established method of calculating MTBF is described in the most recent edition of MIL-HDBK-217.

Mean Time To Failure - The equivalent of MTBF for non-field-repairable units.

No Load Voltage - Terminal voltage of a supply when no current is flowing in external circuit.

Noise - The aperiodic random component on the power source output that is unrelated to source and switching frequency. Unless specified otherwise, noise is expressed in peak-to peak units over a specified bandwidth. See *Ripple*.

Nominal Value - The stated or objective value of a quantity or component, which may not be the actual value measured.

Operating Temperature Range - The range of ambient, baseplate, or case temperatures through which a power supply is specified to operate safely.

Output - One supply voltage (See *Channel & Application Notes*). DC/DC converters usually are single or dual outputs, but some are triples. A single output has one isolated voltage, either positive OR negative. A dual output has positive AND negative voltages as in a traditional operational amp. application. A triple output is a combination of the two. Usually there is an isolated 5V, as well as both positive AND negative voltages.

Output Filter - One or more discreet components used to attenuate output ripple and noise.

Output Ripple and Noise - See *Periodic and Random Deviation*.

Output Voltage Accuracy - The tolerance in percent of the output voltage.

Overload Protection - A feature that senses and responds to current of power overload conditions.

Over-voltage Crowbar - See *Crowbar*.

Over-Voltage Protection (OVP) - A feature that senses and responds to a high voltage condition.

PARD - Abbreviation for Periodic and Random Deviation.

Periodic and Random Deviation (PARD) - The sum of all ripple and noise components measured over a specified bandwidth and stated, unless otherwise specified, in peak-to-peak values.

PI Filter - A filter consisting of two line-to-line capacitors and a series inductance in a configuration used to attenuate noise and ripple.

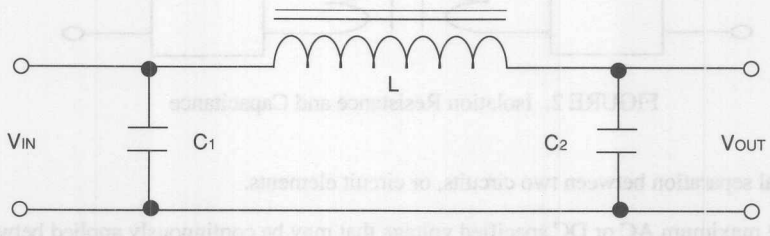


FIGURE 3. PI Filter

Post Regulation - Refers to the use of a secondary regulator on a power supply output to improve line/load regulation and to attenuate ripple and noise.

Preregulation - The initial regulation circuit in a system containing at least two cascade regulation loops.

PSMA - Abbreviation for Power Sources Manufacturers Association.

Pulse - Width Modulation - A method of regulating the output voltage of a switching power supply by veering the duration, but not the frequency, of a train of pulses that drives a power switch.

Push-Pull Converter - A power switching circuit that uses two or more switches driven alternately on and off.

PWM - Abbreviation for Pulse-Width-Modulation.

Rated Output Current - The continuous load current under which specifications of a power supply are determined.

Reflected Ripple Current - The AC current generated at the input of a power supply or DC/DC converter by the switching operation of the converter, stated as peak-to-peak or RMS.

Return - The name for the common terminal of the output of a power supply, it carries the return current for the outputs.

Ripple - The periodic component at the power source output harmonically related to source or switching frequencies. Unless specified otherwise, it is expressed in peak-to-peak units over a specified bandwidth.

Short-Circuit Protection - A protective feature limiting the output current of a power supply to prevent damage.

Soft Start - Controlled turn on to reduce in-rush current.

Split Bobbin Winding - The method of winding a transformer whereby the primary and secondary are wound side-by-side on a bobbin with an insulation barrier between the two windings.

Stability - The percent change in output parameter as a function of time, with all other factors held constant, following a specified warm-up period.

Stand-By Current - The input current drawn by a power supply under no load conditions.

Switching Frequency - The rate at which a DC voltage is switched in a converter.

Temperature Coefficient - The average percent change in output voltage per °C change in ambient temperature over a specified temperature range.

Temperature Range, Specification - The range of temperatures under which the power supply operates fully within all specifications.

Temperature Range, Operating - The range of temperatures under which it is safe to operate but one or more parameters might go out of specification.

Temperature Range, Storage - The range of temperatures through which an inoperative power supply can remain in storage without degrading its subsequent operation.

Transformer - Device that transfers energy from one circuit to another by means of electromagnetic induction.

Transient Recovery Time - The time required for the output voltage of a power supply to settle within specified output accuracy limits following a sudden change in line or load.

UL - Abbreviation for Underwriters Laboratories Incorporated.

UPS - Abbreviation for Uninterruptible Power Supply.

VDE - Abbreviation for *Verband Deutscher Electotechniker*. A German organization that tests equipment for public safety and emitted noise.

Voltage Balance - The difference in magnitude, in percent, between differential tracking output voltages of a power supply where the voltages have equal nominal values with opposite polarities.

Warm-Up Drift - The change in output voltage of a power source from turn-on until it reaches thermal equilibrium at specified operating conditions.

BURR-BROWN USA SALES OFFICES AND SALES REPRESENTATIVES

BURR-BROWN WORLDWIDE HEADQUARTERS
International Airport Ind Park
Mailing Address:
PO Box 11400
Tucson, AZ 85734
Street Address:
6730 S. Tucson Blvd.
Tucson, AZ 85706
Tel: (602) 746-1111
Cable: BBRCORP
Telex: 066-6491
FAX: (602) 889-1510

ALABAMA
REP Inc.
PO Box 4889
11535 Gilleland Road
Huntsville, AL 35815-0889
Tel: (205) 881-9270
FAX: (205) 882-6692

ALASKA
Burr-Brown Corporation
523 S. Washington Ave.
Kent, WA 98032
Tel: (206) 859-9220
FAX: (206) 859-9276

ARIZONA
Morrison and Fern Inc.
6601 E. Grant Road
Suite 115
Tucson, AZ 85715
Tel: (602) 296-8181
FAX: (602) 296-4833

ARKANSAS
Burr-Brown Corporation
11910 Greenville Ave.
Suite 502, LB-4
Dallas, TX 75243
Tel: (214) 783-4555
FAX: (214) 783-2717

CALIFORNIA (Northern)
Burr-Brown Corporation
1975 Hamilton Avenue
Suite 6
San Jose, CA 95125
Tel: (408) 559-8600
FAX: (408) 879-2405

I^2 Incorporated
3350 Scott Blvd.
Building 10
Santa Clara, CA 95054
Tel: (408) 988-3400
Fax: (408) 988-2079

CALIFORNIA (Southern)
Burr-Brown Corporation
28720 Roadside Drive
Suite 274
Agoura Hills, CA 91301
Tel: (818) 991-8544
FAX: (818) 991-7872

Burr-Brown Corporation
2001 E. Fourth Street
Suite 104
Santa Ana, CA 92705
Tel: (714) 835-0712
FAX: (714) 541-5621

COLORADO
Burr-Brown Corporation
9025 Grant Street, Suite 108
Denver, CO 80229
Tel: (303) 452-3545
FAX: (303) 452-3652

CONNECTICUT
Burr-Brown Corporation
984 Northy Broadway
Suite 402
Yonkers, NY 10701
Tel: (914) 964-5252
FAX: (914) 964-0655

DELAWARE
QED Electronics Inc.
PO Box 487
805 North Bethlehem Pike
Spring House, PA 19477
Tel: (215) 643-9200
FAX: (215) 643-9213

FLORIDA
V.G. Sales Company, Inc.
608 E. Altamonte Drive
Suite 106
Altamonte Springs, FL
32701
Tel: (407) 831-8688
FAX: (407) 830-0627

V.G. Sales Company, Inc.
12360 66th Street N
Suite M
Largo, FL 34643
Tel: (813) 536-7787
FAX: (813) 530-9126

V.G. Sales Company, Inc.
1001 N. W. 62nd Street
Suite 205
Fort Lauderdale, FL 33309
Tel: (305) 938-4333
FAX: (305) 938-4331

GEORGIA
Rep Inc.
1944 Northlake Parkway #1
Tucker, GA 30084
Tel: (404) 938-4358
FAX: (404) 938-0194

HAWAII
Burr-Brown Corporation
28720 Roadside Drive
Suite 274
Agoura Hills, CA 91301
Tel: (818) 991-8544
FAX: (818) 991-9872

IDAHO
Burr-Brown Corporation
523 S. Washington Ave.
Kent, WA 98032
Tel: (206) 859-9220
FAX: (206) 859-9276

ILLINOIS (Northern)
Burr-Brown Corporation
85 W. Algonquin Rd. Ste. 310
Arlington Heights, IL 60005
Tel: (708) 437-2877
FAX: (708) 437-2996

ILLINOIS (Southern)
B.C. Electronic Sales, Inc.
3759 Pennridge Drive
Bridgeton, MO 63044
Tel: (314) 739-6683
FAX: (314) 344-3180

INDIANA (Northern)
Burr-Brown Corporation
85 W. Algonquin Road
Suite 310
Arlington Heights, IL 60005
Tel: (708) 437-2877
FAX: (708) 437-2996

INDIANA (Southern)
Burr-Brown Corporation
10945 Reed Hartman Hwy.
Suites 313 & 315
Cincinnati, OH 45242
Tel: (513) 891-4711
FAX: (513) 891-4713

IOWA
Rep Associates Corporation
4905 Lakeside Drive NE
Cedar Rapids, IA 52402
Tel: (319) 373-0152
FAX: (319) 373-0217

KANSAS
B.C. Electronic Sales, Inc.
1140 Adams
Kansas City, KS 66103
Tel: (913) 342-1211
FAX: (913) 342-0207

KENTUCKY
Burr-Brown Corporation
10945 Reed Hartman Hwy.
Suites 313 & 315
Cincinnati, OH 45242
Tel: (513) 891-4711
FAX: (513) 891-4713

LOUISIANA (Northern)
Burr-Brown Corporation
11910 Greenville Avenue
Suite 502, LB-4
Dallas, TX 75243
Tel: (214) 783-4555
FAX: (214) 783-2717

LOUISIANA (Southern)
Burr-Brown Corporation
9888 Bissonnet
Suite 572
Houston, TX 77036
Tel: (713) 988-6546 or
(512) 473-2311 (Austin)
FAX: (713) 988-6548

MAINE
Burr-Brown Corporation
85 Rangeway Road
North Billerica, MA 01862
Tel: (508) 670-9800
FAX: (508) 670-9809

MARYLAND
Marktron Inc.
1688 East Gude Road
Suites 302 & 304
Rockville, MD 20850
Tel: (301) 251-8990
FAX: (301) 424-0766

Marktron Inc.
54 Scott Adam Road
Suite 206
Hunt Valley, MD 21030
Tel: (301) 628-1111
FAX: (301) 628-9351

MASSACHUSETTS
Burr-Brown Corporation
85 Rangeway Road
North Billerica, MA 01862
Tel: 508-670-9800
FAX: 508-670-9809

MICHIGAN
Burr-Brown Corporation
38345 W. Ten Mile Road
Suite 320
Farmington, MI 48335
Tel: (313) 474-6533
FAX: (313) 474-7379

MINNESOTA
Electronic Sales Agency Inc.
8120 Penn Avenue South,
#160
Bloomington, MN 55431
Tel: (612) 884-8291
FAX: (612) 884-8294

MISSISSIPPI
Rep Inc.
PO Box 4889
11535 Gilleland Road
Huntsville, AL 35815-0889
Tel: (205) 881-9270
FAX: (205) 882-6692

MISSOURI
B.C. Electronic Sales, Inc.
3759 Pennridge Drive
Bridgeton, MO 63044
Tel: (314) 739-6683
FAX: (314) 344-3180

MODEL INDEX